FOUNDRY TRADE JOURNAL

EST. 1902

WITH WHICH IS INCORPORATED THE IRON AND STEEL TRADES JOURNAL

VOL. 100
No. 2066
Registered at the G.P.O. as a Newspaper

MAY 17, 1956
Offices: John Adam House, John Adam St., London, W.C.2

Single Copy, 9d. By Post 11d. Annual Subscription, Home 40/-, Abroad 45/- (Prepaid)

UNIV. OF MICHIGAN
JUN 14 1956
EAST ENGINEERING LIBRARY

SAND

for Shell Moulding

and CO_2 Process

Enquiries to :—

THOS W. WARD LTD

TWW

ALBION WORKS, SHEFFIELD. PHONE 26311 (22 LINES)

LONDON OFFICE: BRETTENHAM HOUSE LANCASTER PLACE STRAND W.C.2.

ASK YOUR FACTORY INSPECTOR

The provisions of the Iron and Steel Foundries Regulations, 1953, are now being enforced. For controlling dust generated by pedestal grinders the Dusgard is the complete answer.

Dusgards are available either direct from the *sole manufacturers,* ACI Ltd., or through your regular contractor. If you have not already received your copy of the Dusgard leaflet why not ask our nearest branch for one today?

DUSGARD TRADE MARK

for protection in the DANGER ZONE

We are specialists in every form of Foundry dust control.

ACI

AIR CONTROL INSTALLATIONS LTD

Ruislip Middlesex . . Ruislip 4066

LONDON Welbeck 1306 | BIRMINGHAM Midland 1165 & 1367 | MANCHESTER Central 0679 & 0670 | NEWCASTLE Whitley Bay 23046 | GLASGOW Central 2923

FOUNDRY TRADE JOURNAL

Established 1902

Vol. 100 Thursday, May 17, 1956 No. 2066

Editor:
V. C. FAULKNER, F.R.S.A., HON.M.I.B.F.

Assistant Editor: A. R. PARKES, M.I.B.F.
Commercial Editor: P. E. CARDEN.
Advertising Manager: LENNOX HOLT, M.I.B.F.
Production Manager: R. J. LOVELL.
Publisher: H. J. DWYER
Circulation Manager: E. T. GRIFFITHS.

District Representatives:
G. P. ELLIOTT (*Northern Area*)
T. H. SMITH (*Scotland*)

PRINCIPAL CONTENTS

Technical : PAGE

Latest Developments in Spheroidal-graphite Cast Iron, by W. W. Braidwood : The history of s.-g. iron is traced, commencing with the earliest experiments and leading up to the methods now established for treatment of the metal by the use of metallic magnesium. The lesser known properties of the material are dealt with, also some of its more interesting applications . . 321

Dimensionally-accurate Castings, by J. Hill: Subjects dealt with in the concluding part of the Paper include: Mould pressures, gating and feeding practice; equipment—machines, patterns, jigs and gauges; physical inspection; and casting design 331

Features :

Leader: Automation in Foundry Practice . 319
Forty Years Ago 320
Equipment and Supplies 337
Notes from the Branches 339
Publications Received and Book Reviews 340

Commercial :

Company News 336
Pig-iron and Steel Production . . 342
Imports and Exports of Iron and Steel . 344
Raw Material Markets 348
Current Prices of Iron, Steel, and Non-ferrous Metals (Advert. section) . 44

AN INDUSTRIAL NEWSPAPERS PUBLICATION

Published Weekly

Single copy 9d.; by post 11d.;
Annual subscription : home 40s., abroad 45s. (prepaid).

17/19 JOHN ADAM STREET, ADELPHI, LONDON, W.C.2

'Phone: TRAfalgar 6171 (10 lines)
'Grams: Zacatecas, Rand, London.

Automation in Foundry Practice

Much as we dislike the word, automation has to be regarded seriously, as it has become a talking point in industrial and trade union meetings. When considering this subject it is usual to refer to American advances, and in this connection, in company with Mr. Butler, secretary of the Council of Ironfoundry Associations, we were privileged, by courtesy of the Central Office of Information, to see a film sponsored by the American Foundrymen's Society. The film, which should be made available for general release to the foundry industry of this country, traces the development of methods in casting production, beginning with an installation having a couple of moulding machines, using snap flasks, and man-handling the moulds to fill the foundry floor, and leading up to the modern wholly-mechanized plants. A trend towards the use of a circular, rotating table, where moulding is effected by sand slinging was observed, but in the film there was a distinct difference from the usual concept, as, not only was the positioning of the impeller head over the mould automatic, but the path taken was similarly regulated. This resulted in less spillage, and uniform ramming hardness was attained, as the time taken was also controlled. The rammed moulds were automatically strickled off, a system already available in this country. A factor which impressed us was the core-setting, wherein two men using both hands simultaneously, exhibiting a precision of movement to be associated with a well-trained *corps de ballets*. It is a film which needs to be seen more than once to absorb the details which are so clearly shown. Even the earlier phases of mechanization which are depicted are worth emulation, because in this section the problems of the smaller foundries have been so intelligently and effectively tackled.

Another note from America is of great interest to the larger mechanized foundries; it is that American automobile machine-shops are installing much heavier machine-tools, well capable of dealing with unfettled castings straight from the foundry. If this becomes general practice, it will mean the closing down of "Cinderella's beauty parlours" attached to the repetition foundries, and with that the solution of quite a few problems. The foundry industry has long been in the forefront of automation and the few examples we have given indicate future trends. A conception of automation is the substitution of handling by mechanical processing, and this is exemplified by automatic strickling, but we should regard the machining of unfettled castings not as automation but as a new development.

G

National Society of Master Patternmakers

Second Annual General Meeting

The second annual general meeting of the National Society of Master Patternmakers was held last Saturday at the Queens Hotel, Birmingham, Mr. B. Levy presiding. The minutes of the annual general meeting held in London on May 6, 1955, having been approved, the chairman gave a valedictory address in which he reviewed the activities of the Society during the past year. There had been a useful increase in membership; standardized conditions of sale had been established and made available as a stereo for use by the members; monograms had been issued for use on members' stationery; a code of practice for use when preparing wooden patterns was approaching completion in collaboration with the British Standards Institution; there had been works visits, to the works of the West Yorkshire Foundries, Limited, Leeds, and Wadkins, Limited, of Leicester; and finally there had been the first-ever visit by a group of master patternmakers to another country with the objective of exchanging technical information. This latter had taken the form of an organized tour of nine patternshops in the Paris region, a technical school, and other important organizations. The hosts on this occasion had been given a hearty and pressing invitation to visit this country at a time of their own choosing.

The chairman then presented the Levy Silver Medal to Mr. D. H. Potts, of the Westinghouse Brake & Signal Company, Limited, for his outstanding contribution to the British development of the pressure-cast aluminium patternplate. The excellence of his work had already been acknowledged by the award of a diploma by the Institute of British Foundrymen; moreover, his papers on the subject had been translated into a number of foreign languages. In acknowledging the award, Mr. Potts said he had only attained success through the wholehearted co-operation of his colleagues at Chippenham.

Election of Officers

The following were elected to fill the various offices for the forthcoming session. As president: Mr. L. Brown (Birmingham); as vice-president: Mr. Norman Gott (Lancashire); as new members of Council: Mr. W. J. Stansby (London), Mr. R. W. Mousley (Leamington), Mr. H. R. Dowler (Birmingham), and Mr. J. J. Harvey (Manchester). Two retiring members of Council, Mr. Rowen and Mr. Whitehouse, were re-elected. Mr. J. Vickers (Darlington), owing to pressure of business, has retired and was cordially thanked for his services. Mr. Firkins, of Fisher, Firkins, was elected secretary, and Mr. Whitehouse the honorary auditor.

Mr. Levy, on behalf of the members, then presented to Mr. Godfrey Judd, a partner of Mann, Judd & Company, the retiring secretaries, with a set of pewter tankards in recognition of the great services he had given in the formation of the Society and its subsequent operation. Mr. Judd, in thanking the members, regretted the unavoidable severance from the Society as he had so much enjoyed his association with the members.

The second annual dinner, dance and cabaret was held that evening at the Station Hotel, Dudley. It was well attended and Mr. Levy—the retiring president—took the chair. Sir Percy H. Mills, Bt., was the principal guest, and he replied to the toast of "the Guests," proposed by Mr. N. Gott. "The Society" was proposed by Mr. C. H. Morris and the chairman replied. Another honoured guest was Mr. John Bell, immediate past-president of the Institute of British Foundrymen. Amongst those at the high table were Dr. A. B. Everest, president of the Institute of British Foundrymen; Mr. G. Judd, C.A., and Mr. V. C. Faulkner, all of whom were accompanied by their ladies. The organization of this function was carried out by Mr. L. Brown and Mr. Walter Hartley.

Forty Years Ago

In the issue of the FOUNDRY TRADE JOURNAL for May, 1916, the Editor was very caustic about the Factory Regulations. To quote "As every foundryman knows too well, it is easier to formulate a code of restrictions prohibiting excessive fumes, steam and dust in the foundry than it is to arrange for their removal. One of the weak features of the Regulations governing brass-casting shops in this country is the fact that no particular system or class of apparatus is even recommended for the removal of brass-casting fumes. The method of dealing with the question in many foundries seems to be somewhat on the following lines:—Instal some appliance for removing the fumes (efficacy is not the prime essential), claim for it absolutely satisfactory operation, and take care there is no excess of fumes in the shop when the inspector calls. The latter will then not experience any mental perturbation and everybody (except, of course, the moulders and casters) will be pleased." He then reviewed the Regulations recently enforced by the Pennsylvania State Industrial Board. They read very much like those which have resulted from the Garrett Report. Amongst new companies registered appeared the name of the Goldendale Iron Company, Limited. Amongst the advertisements was the offer of 10 cwt. of lycopodium.

Latest Foundry Statistics

According to the monthly statistical *bulletin* of the Iron and Steel Board, the number of persons engaged in steelfounding on March 10 was 20,260, an increase of 70 on the February figure, representing 80 males and the loss of 10 females. The average weekly output of steel castings during March was 6,400 tons, which shows a slight decrease over February and a corresponding increase over March, 1955. The average weekly amount of metal melted to be put into steel castings was 12,000 tons. Thus the yield is not much over 53 per cent.

Accommodation in Cardiff

Any readers who are having difficulty in securing hotel accommodation in Cardiff for the conference there of the Institute of British Foundrymen, June 11 to 15, should get in touch with Mr. G. Lambert, the secretary, at the Institute's head office in Manchester.

Chairmanship of National Steel Foundry (1914), Limited

When referring to Wadkin, Limited, in last week's issue (page 311), it was stated that Sir Holland Goddard is chairman also of the National Steel Foundry (1914), Limited. Actually, of course, this latter concern was acquired by Lake & Elliot, Limited, last year, and Mr. C. H. Kain is its chairman. Apologies are tendered to both the firms and readers for this mistake.

Latest Developments in Spheroidal-graphite Iron

By W. W. Braidwood

MR. W. W. BRAIDWOOD since 1946 has been attached to the Development and Research Department of the Mond Nickel Company Limited. He commenced work with the National Steel Foundry (1914) Limited, Leven, and was successively with Forth and Clyde Steel Foundry, Babcock & Wilcox Limited, and Stanton Ironworks Company, Limited, before joining his present firm.

Mr. Braidwood has lectured in Belgium, France, Italy and Sweden and was awarded the Diploma of the Institute for a paper given in 1939.

The Author, who has been intimately connected with the development of spheroidal-graphite iron since its inception, describes the progress made, especially during the last three years and with particular reference to the methods now established for treatment of metal by the use of metallic magnesium, to the less-realized properties of this versatile material which are contributing greatly to its expanding field of use, and to some of its most interesting applications. Only six years have elapsed since commercial production of s.-g. iron began in Europe. Licences to manufacture have now been granted by the Mond Nickel Company and the International Nickel Company to a total of 340 firms in 27 countries ; output has already reached large figures, and a mass of practical experience has been accumulated. The Author has previously prepared progress reports,[1,2,3] and this further Paper describes especially the salient developments taking place over the three years which have elapsed since his last report. The Paper was presented in January to the London branch of the Institute of British Foundrymen.

At the outset, for the manufacture of spheroidal-graphite cast iron, use was made only of addition alloys consisting essentially of nickel and magnesium. These continue to be widely used and demand has long exceeded availability. Not only have supplies been inadequate but treatment of iron by such means is relatively expensive and, ethically speaking, nickel should be used only where it is required in the end product, as in the high-strength and harder grades. In the early days, much attention was given to possible alternative addition alloys. Those of the copper-base type proved impracticable because of their lower efficiency, the interfering effect of copper on the graphite form and its marked influence on pearlite stability. Magnesium/ferro-silicon alloys, despite their lower efficiency and the corresponding need for heavy addition—with doubtful economic advantage and some technical disadvantages—have continued to be used in suitable circumstances. However, the ideal solution obviously lay in use of metallic magnesium and, with the full encouragement and support of the licensors, much has been achieved along that line. The evolutionary steps of this method of addition make a fascinating story best told chronologically.

Use of Metallic Magnesium

An early idea was to plunge metallic magnesium in various physical forms, alone or in association with diluents, into molten iron. This was done by White *et al*[4] in the USA, by experimenters in the USSR[5] and by Longaretti and Noris[6] in Italy. The last-mentioned method* which involves plunging of magnesium chippings into molten iron, continues in use by the originators, Ansaldo, S.A., and by three other licensed producers of s.-g. iron in Italy.

The next idea was to introduce granulated magnesium at controlled rate. The first step in this direction was taken by Marinček[7]‡ of Ludwig von Roll'schen Eisenwerke, A.G., Switzerland, who fed powdered magnesium into a graphite tube immersed vertically within the ladle of iron. The magnesium volatilized within the tube and the vapour bubbled through the iron. Subsequently, Schreiber of Tiroler Röhrenwerke u. Metallwerke, A.G.,§ Austria, invented the " lance injector," which blows magnesium powder in a stream of nitrogen through an air-cooled, refractory-sheathed tube into the molten iron. This apparatus is in routine use by Tiroler and by three other licensed producers of s.-g. iron. Seven further injectors are currently being installed.

A further idea was to treat molten metal in a closed vessel, so enabling the first-formed magnesium vapour to build up pressure equal to the vapour-pressure of magnesium at the temperature of the iron treated. With that position reached, further vapour cannot be formed and the rest of the magnesium remains in liquid form to react with sulphur and enter into solution in the iron. The first " sealed ladle," that designed and constructed by Metallgesellschaft, A.G.,¶ in Germany, was or horizontal, cylindrical type. Lump magnesium was accommodated in the air-tight, hollow cover, which had sealing faces of graphite. The ladle was filled with iron, the cover secured and the ladle inverted, so bringing the magnesium into

* Italian Patent No. 485,770 and British Patent No. 734,860.

‡ Swiss Patent No. 291,858 and British Patent No. 716,858.
§ Austrian Patent Application No. 5305/52.
¶ German Patent Application No. M16060 and British Patent Application No. 743,456.

contact with the molten iron. This procedure worked satisfactorily but did not proceed beyond the pilot-plant stage because of the evolution almost immediately of a variation of the same basic principle which had the advantages of providing a safety valve and keeping the sealing faces out of contact with molten metal. This modified sealed ladle was invented by Klingbeil of Schüchtermann und Kremer-Baum A.G.,* Germany.

The principle of the S.K-B. design is illustrated in Fig. 1. It will be seen that a cover, actually an s.-g. iron casting, closes the ladle except for a central, circular aperture large enough to receive

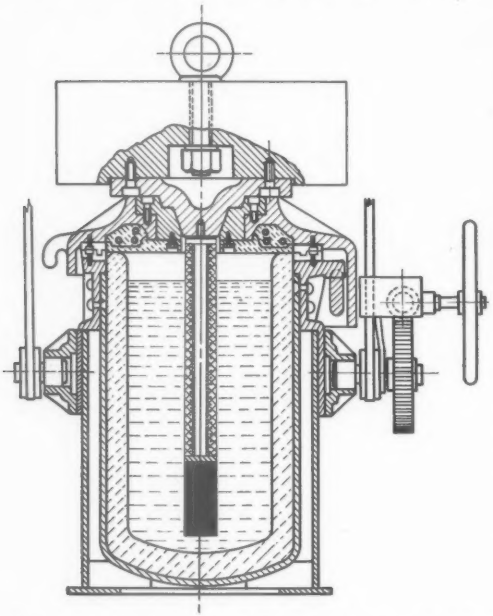


FIG. 1.—*Arrangement of the S.K-B. type of sealed ladle for the addition of metallic magnesium to molten iron.*

the plunger which comprises a refractory-coated stem with the magnesium positioned at its lower end. Originally, magnesium ingot or stick was contained within a mild-steel tube welded to the stem, but use is now made of cylindrical billets of magnesium screwed into the stem and protected by a refractory coating from premature reaction during immersion. A further development involves the use of sheathed billets prepared by casting magnesium into thin-walled steel tubes. On full insertion of the plunger, the ladle is automatically sealed under the deadweight of the plunger head, or pneumatically. The load applied is sufficient to resist the expected upward thrust but would be overcome

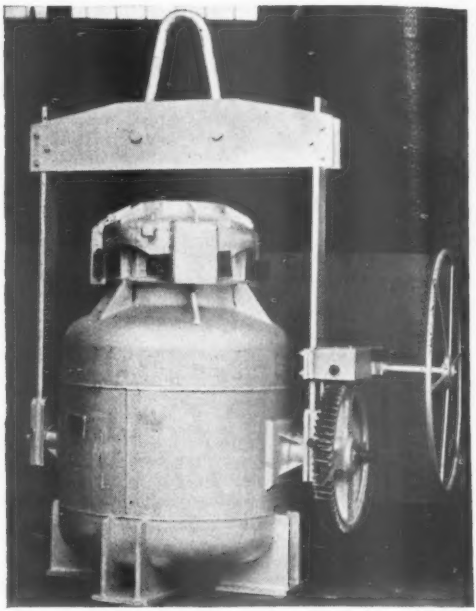


FIG. 2.—*Sealed ladle of S.K-B. design and 5 tons capacity.*

by any pressure appreciably greater than that expected and certainly well below that at which the ladle itself is tested. This equipment is in use by some 30 licensees and, to date, many thousands of treatments of from half-ton to five tons each, have been carried through with satisfactory results and great economy. Fig. 2 shows a 5-ton ladle which is in routine use in Germany.

The next evolutionary step was the invention of the pressure chamber by Grandpierre of Société des Fonderies de Pont-à-Mousson, S.A.,† France. Imposition within the chamber of a pressure greater than the vapour pressure of magnesium at the temperature of the molten iron prevents vaporization of the subsequently added magnesium which is liquified only. The original apparatus (illustrated in Fig. 3) consisted essentially of a strong chamber with a swinging head and closable by hydraulic pressure applied to the base. Lump magnesium was placed within the plunger and a system of pipes and valves effected introduction and eventual release of the gas used to build up the required pressure. A pneumatic cylinder and piston, operating through a stuffing box in the cover, actuated the plunger. The method of operation was as follows:—

An ordinary ladle containing the quantity of iron to be treated was placed within the chamber; the cover was then swung over to the secure position and the chamber closed by action of the hydraulic

* German Patent Application No. Sch.13193.

† Patent applications pending.

ram. The necessary pressure was then built up within the vessel and the plunger subsequently immersed in the iron and moved up and down to effect thorough mixing of the liquid magnesium with the molten iron. When the reaction was complete, the plunger was raised, the pressure released, the hydraulic ram lowered, the cover swung aside and the ladle removed for pouring. Use was made initially of argon and then of nitrogen, to provide the high-pressure atmosphere, but compressed air was found practicable and is now in routine use.

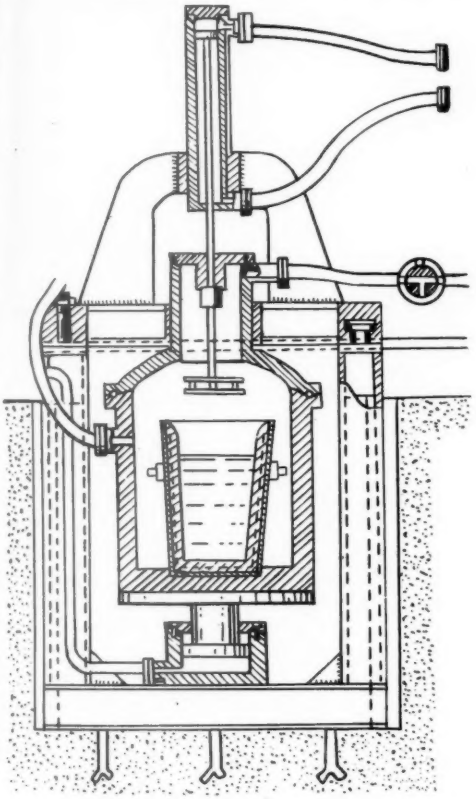


FIG. 3.—*Arrangement of the original Pont-à-Mousson pressure chamber for the addition of metallic magnesium.*

The pilot-plant apparatus which treated unit quantities of 200 kg. (about 4 cwt.), was employed for a total of some 200 exploratory treatments before a larger apparatus, constructed on the same principle but embodying several ingenious mechanical improvements, came into commercial use by Pont-à-Mousson, who are producing s.-g. iron on a large scale, particularly as spun pipe.

The methods for treatment with metallic magnesium under pressure may be regarded as the most

(Courtesy, Hepworth & Grandage Limited.)

FIG. 4.—*Component of car door-lock, in quantity production, from shell moulds in s.-g. iron.*

perfect technically. Not only is the magnesium in the most inexpensive form, but since recovery is high, the necessary addition is low and the heat loss correspondingly small. Moreover, magnesia fume is virtually absent. Furthermore, these procedures particularly lend themselves to the technique of over-treatment with magnesium and subsequent dilution with untreated iron.* The dilution possible is dependent on the sulphur content of the iron provided. Where that is low, as in iron from the basic cupola or electrically melted, dilution by an additional three units is already practised and even greater dilution can be effected. Such technique makes it possible to use a sealed ladle or a pressure chamber of much smaller size than would otherwise be necessary, and also facilitates provision of specially hot and fluid iron with utmost economy.

Nickel-free Alloy

Notwithstanding the availability of the methods already described, there is still need for a flexible method of treatment requiring minimum equipment, involving no use of scarce materials, and capable of treating small quantities of iron readily, reliably, simply and inexpensively. This would suit particularly foundries of moderate size and those making light castings. Fulfilment of this need seems certain following the recent advent of the latest in a long list of exploratory nickel-free alloys. This new alloy, the first of its class to be as efficient as nickel-magnesium, halves the cost of treatment. It is

* British Patent Application No. 743,469.

FIG. 5.—*Auger in oil-quenched and tempered s.-g. iron.*
(Courtesy, Valmet Oy, Finland.)

already established in routine use in the foundry of one licensee in Europe and such use will spread rapidly when equipment now being installed for its large-scale manufacture comes into operation.

Need for Suitably Equipped Foundries

This report may have shown already that great progress, both technical and economic, has been made in magnesium treatment. By itself, however, that is not enough! The bulk of the s.-g. iron so far produced has come from foundries designed for the manufacture of castings in other metals. Obviously, its full potentialities cannot be developed until, and unless, the material is made in shops, or even separate foundries, suitably designed and equipped for the purpose. Happily, this is appreciated by an increasing number of forward-thinking producers, who have built or are building new shops. Similar improvements are being effected by other firms as the prerequisite to receiving licences.

Provision of fully suitable facilities begins with melting. Until recent years, coke of good quality has been readily available in Britain at reasonable cost and the ordinary cupola has long been an inhabitant of every British ironfoundry. For the preparation of s.-g. iron, however, this furnace has well-known disadvantages; the charges must include relatively expensive pig-iron and the tapped iron is high in sulphur, requiring proportionately heavy treatment, with corresponding loss of temperature. Thus, the ordinary cupola can be used, but only under these considerable handicaps; s.-g. iron deserves and must have a better furnace, if production technique is to be efficient and economic.

Improvements can be effected by heating the cupola blast and providing a neutral or basic lining, as has already been done in many cases, especially abroad. However, the most attractive arrangement often involves electric melting of synthetic iron from charges consisting essentially of steel scrap and carbon. Such iron is low in cost and ideal in composition. All types of electric furnaces are in use, but the recently-developed, coreless, mains-frequency furnace, which particularly suits the iron foundry and is making marked headway abroad, seems certain to come into greater use in this country also, especially for this purpose.

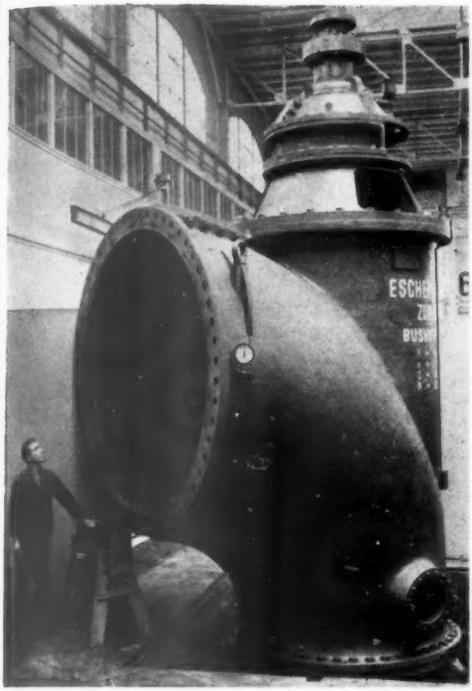
A foundry so equipped, operating one of the methods for magnesium treatment without use of nickel, having completely suitable facilities for heat-treatment and a layout promoting production flow, is in an excellent position to make s.-g. iron castings with such efficiency and economy as to ensure satisfactory development of existing and potential markets.

Effect on Malleable Founding

So long as use had to be made of nickel-base alloy, castings in s.-g. iron have generally cost as much or more than those in conventional malleable iron, but the position is changing, and although the malleable foundry industry might truly say that the impact of s.-g. iron on its field has been hardly noticeable so far, due regard must be given to the influence which provision of fully-suitable facilities will exert. Consideration must especially be given to the markedly shorter heat-treatment cycle, the convenience of casting a graphitic instead of a necessarily white iron, and the unrestricted range of section thickness and mass all made possible by change to s.-g. iron. Competition with conventional malleable iron must become more and more noticeable even in the traditional field of small castings. In that connection, Fig. 4 is probably of special interest.

Reference might fittingly be made at this point to the recent forecast by Wittmoser[8], whose opinion is surely authoritative and unbiased, that "... it can already be estimated that the future extent of manufacture of s.-g. iron will correspond roughly to the volume of steel and malleable castings together." It should not be inferred from the remarks made on this subject, that replacement of malleable iron represents a major field for s.-g.

FIG. 6.—*Mechanism for a foundry crane, incorporating gear wheels in s.-g. iron of identical composition but differing hardness.*
(Courtesy, S.A.F.F.I. Ingg. de Bartolomeis, Italy.)



(*Courtesy, Escher Wyss, A.G., Switzerland.*)

FIG. 7.—*S.-g. iron casing for an axial-flow pump; made in halves, each weighing* 17 *tons.*

iron—indeed, as the remainder of this Paper should amply demonstrate—it is a relatively small part of the potential. Spheroidal-graphite iron is establishing its own place among metals available for industrial use and should not be regarded merely as a substitute for this, that or the other, conventional metal. Its outstanding mechanical and other properties, and sometimes unique combinations of these, together with its versatility, ease of production and increasing economy, are rapidly expanding its use.

Mechanical Properties and Heat-treatment

Specifications covering the normal mechanical properties and the grades of s.-g. iron most in use have already been prepared in several countries, and issue of the first British Standard, to cover three grades, is expected early this year. Because of the variations made possible by modifications in composition and heat-treatment, there will certainly be many additional specifications.

Spheroidal-graphite iron is peculiarly responsive to all types of heat-treatment and can be alloyed to develop special matrix structures and properties. It may be regarded as having its own "bank," from which carbon may be drawn or into which carbon may be deposited as desired. When the softest condition is required, full annealing expels carbon from the matrix and deposits it in the spheroids with formation of ductile ferrite exhibiting hardness of around 150 Brinell. When hardness is needed, a short period at austenitizing temperature recharges the matrix with carbon and subsequent quenching gives hardness up to 700 Brinell. Local hardness of that order can be developed on wearing faces by flame- or induction-hardening, and a wide range of intermediate hardness, from 550 to 250 Brinell associated with tensile strength of from 70 to 50 tons per sq. in. can be developed by oil-quenching and tempering. Fig. 5 shows an auger of the type now in quantity production and use by people with unique knowledge of woodworking and experience of extreme climatic conditions. In this application, oil-quenched and tempered s.-g. iron is claimed to be out-performing tool steel.

Properties typified by 0.5 per cent. proof stress of 40 tons per sq. in., tensile strength of 50 tons per sq. in., elongation of 4 per cent. and hardness of 280 Brinell, the best combination for many purposes, are developed by normalizing, which involves holding for a period of 1 to 4 hours at a temperature in the range 800 to 900 deg. C. and withdrawing for free cooling in still air. This treatment is becoming increasingly popular.

Such versatility in mechanical properties is a great aid to the engineering user, as exemplified in Fig. 6. In the four-speed hoist shown, the gear on

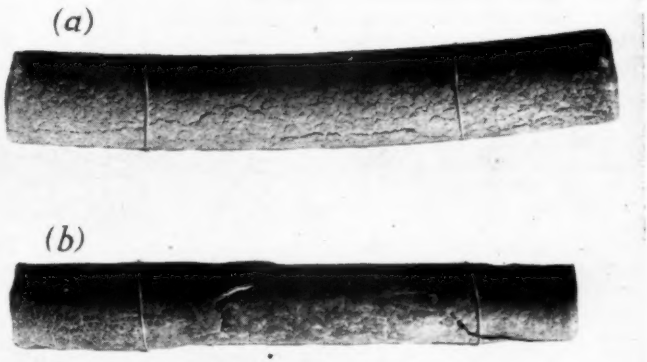


FIG. 8.—*Bars of* (*a*) *grey and* (*b*) *s.-g. iron, initially identical in size, after* 100 *treatment cycles each comprising heating over* 30 *min. to* 850 *deg. C., holding* 1½ *hours and cooling in air.*

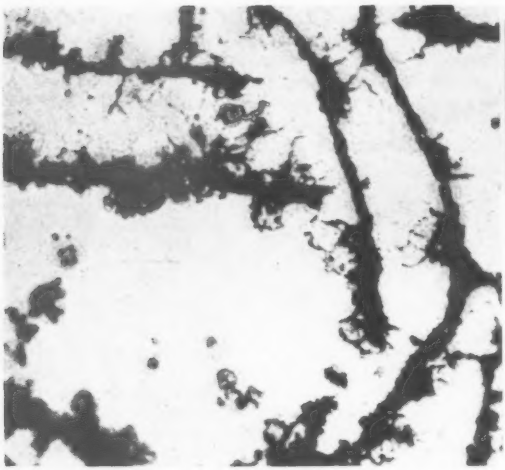


FIG. 9.—*Microstructure at the centre of a grey-iron bar repeatedly exposed to high temperatures.*

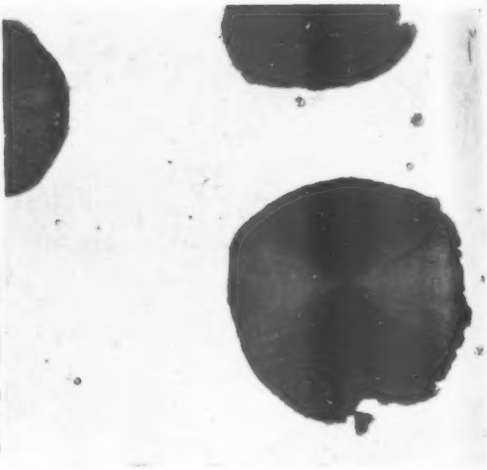


FIG. 10.—*Microstructure at the centre of an s.-g. iron bar similarly exposed to high temperature.*

the drum is annealed, with hardness of 185 Brinell; those of the hoist reducers are normalized, with hardness of 215 Brinell; while the motion wheels are oil-quenched and tempered to 425 Brinell.

So much attention has been focused on the ductility of s.-g. iron that the impression has probably been given that the material is essentially readily bent, twisted or stretched, whereas, in fact, it has high yield strength and modulus of elasticity and can be made very rigid indeed, as is required, for example, in metal-working rolls. The property of high yield strength is also advantageous in such items as the casings and impellers of multi-stage, high-efficiency pumps, which must show no distortion even under high pressures, and in the construction of really heavy-duty pumps such as that shown in Fig. 7. However, the mechanical properties of s.-g. iron have been amply detailed in other papers, most recently by Everest,[9] and this report will direct attention to less obvious, yet potent, characteristics which are contributing to its expanding use.

Other Properties.

The versatility of s.-g. iron goes much beyond the range of mechanical properties which can be developed by alloying or heat-treatment, and involves many other characteristics not readily appreciated or immediately apparent. No steel has a freezing-point temperature so low as 1,150 deg. C.; no grey cast-iron with such freezing point could ever exhibit elongation of 20 per cent.; and no malleable cast-iron with such elongation could be cast in sections ranging from $\frac{1}{8}$ to 40 in. or more, *or* could be cast in the graphitic condition, *or* could contain more than 3.5 per cent. carbon with over 2 per cent. silicon. These attributes are combined in s.-g. iron.

Spheroids v. Flakes

Unlike the flakes of graphite present in grey cast-irons, the spheroids are isolated from one another.

FIG. 11.—*Tube in s.-g. iron for an electric muffle-furnace, to operate at 800 deg. C.* (*Made by Fonderia G. Tagliabue for Ufficio Technico Industriale, Milan*).

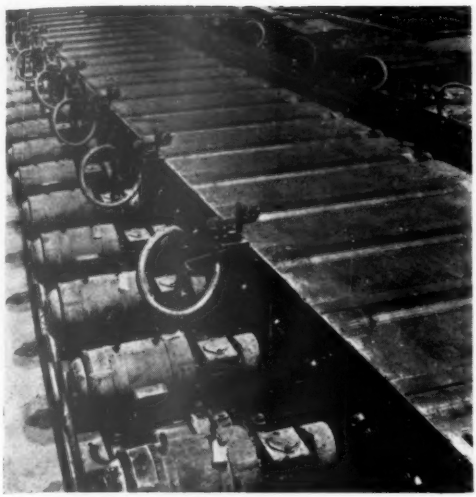


FIG. 12.—*Run-out table using s.-g. iron rollers which handle the hot ingots, blooms and billets, in an American hot-strip mill.*

(Courtesy, S.K.F., Katrineholm and Svenska Aeroplan A.B., Trollhättan, Sweden.)

FIG. 13.—*Combined hub and brake-drum castings for the Saab car.*

This explains the finding by Williams and Lownie[10] that the amount of oxygen absorbed by s.-g. iron on long exposure to the atmosphere is much less than that absorbed by grey cast-iron. For the same reason, s.-g. iron is much more resistant to penetration by oxidizing and corrosive gases on exposure to high temperatures. The resultant reduction in growth is illustrated in Fig. 8, while Figs. 9 and 10 show, respectively, the microstructures of identically exposed grey and s.-g. iron specimens at their centres. Internal oxidation and cracking are evident throughout the grey iron but are absent from the other. This superior resistance to high temperature is being widely utilized; Fig. 11 shows a typical application. Spheroidal-graphite irons containing 5 to 6 per cent. of silicon are markedly resistant to scaling as well as to growth and are in successful use at temperatures in the range 700 to 900 deg. C., replacing high-chromium cast iron and even heat-resisting steels, while high-nickel s.-g. irons of the Ni-Resist type, are in use for vital parts of aircraft engines and other heat- and corrosion-resistant duties.

Advantages of Spheroids.

It is easy to appreciate that change in the graphite form, from flake to spheroidal, minimizes interference with the properties of the matrix. One is inclined to reason, however, that although the spheroidal is the most innocuous form, graphite is a non-metallic inclusion which must always impair the properties and adversely affect the service performance of the material, as compared, for example, with a corresponding steel. But in fact there is often striking advantage conferred by the presence of spheroidal graphite, impressively so in the hot-working roll where the surface is subject to severe thermal shock due to the differences in temperature of the hot steel and the cooling water. Fire-cracks are thus initiated, and extend themselves into the body of the roll. It is a well-known engineering practice to drill a hole at the end of a crack and so stop its spread. Thereafter, if cracking is to continue, it necessitates initiation of a new crack, which is effected less easily than propagation of an existing one. But s.-g. iron rolls contain millions of graphite spheroids which correspond to circular cavities in which cracks tend

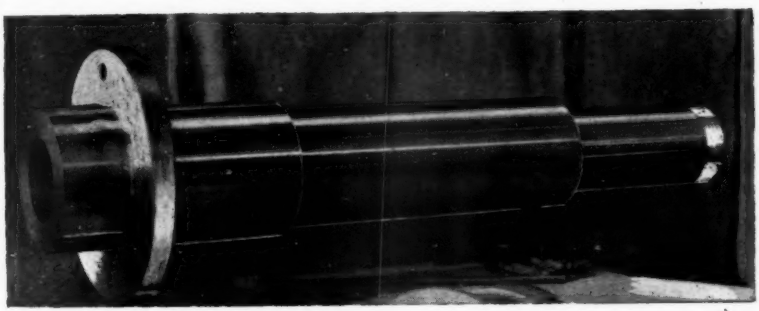


FIG. 14.—*Hollow, main spindle, 6 ft. long and weighing 1¼ tons, as-cast for a girder end-milling machine.*

(Cast by Sandholme Iron Company, Limited, for Kitchen & Wade, Limited.)

FIG. 15.—*Breech casing for a sporting gun.*
(Courtesy, Valmet Oy, Finland.)

to terminate, with the result that in use, such rolls have greater resistance to fire-cracking, and so give longer service between the dressings necessary to maintain an acceptable surface; moreover, since the cracks are shallow the layer of metal removed at each dressing is correspondingly thin.

While it is well known that metal-working rolls represent one of the biggest single items of s.-g. iron production, it may not be generally realized that the new metal is also establishing itself in the auxiliary equipment of rolling mills, particularly for rollers of the type shown in Fig. 12, which handle the hot ingots, blooms and billets, and support or direct the strip.

The beneficial influence of the spheroidal form of graphite on resistance to thermal shock has been demonstrated in an investigation[11] by the British Cast Iron Research Association. This showed s.-g. iron to give the best performance of any of the cast-irons tested and this superiority is being used to overcome thermal cracking in such items as cylinder heads and pistons.

A further and allied field of successful application is that of brake drums. From consideration of earlier practice and theory, s.-g. iron was not thought likely to be suitable for such use. It was believed that an ample amount of flake graphite, in random distribution within an alloyed and strong matrix, gave best results. Surprisingly, however, trials in actual service and under conditions simulating service, have shown s.-g. iron to be outstandingly good as a brake-drum material for heavy duties in industry and transport, and in automobiles also; Fig. 13 shows a group of the brake drums in standard use in a Swedish car.

The presence of graphite, even in the spheroidal form, increases the damping capacity of the metal. This gives s.-g. iron an advantage over steel where it is desired to absorb vibration. For example, tool chatter will be reduced in the milling machine to be used for alignment of structural steelwork on bridge-building construction in India, by making the main spindle in s.-g. iron as the hollow casting shown in Fig. 14. The remarkable and persistent versatility of this metal is further indicated by the fact that since its damping capacity is less than that of grey iron (which gives a dull note on being struck), s.-g. iron has a ringing tone and can be used for bells.

Other Characteristic Properties

The ready machinability of s.-g. iron has in itself been sufficient to justify its use in many instances, and the high finish obtainable, which is well known to those who machine it and evident from several of the illustrations, is a further attraction. Moreover, the facility with which it can be plated and enamelled makes it suitable for many items of decorative trim and chemical plant. It is readily "tinned" and this property, in combination with its high strength and its inherent good bearing properties, makes it ideal for bearing shells*. The white metal layer is perfectly adherent, and in the event of a "run" bearing, damage caused to the

* British Patent No. 659,640—Glacier Metal Company, Limited.

FIG. 16.—*Demonstration of the flexibility of a 6-in. dia. s.-g. iron pipe with screwed joints.*
(Courtesy, Société des Fonderies de Pont-à-Mousson, S.A., France.)

(Courtesy, Société des Fonderies de Pont-à-Mousson, S.A., France.)

FIG. 17.—*Length of 6-in. dia. pipe-line, with screwed joints and bent on site.*

shaft from contact with s.-g. iron is much less than would be the case, for example, with steel. In many cases, this could make all the difference between complete breakdown and ability to "limp home." Indeed, the bearing properties of s.-g. iron are themselves so good that, as shown by a recent investigation in Russia[12], it can be regarded as a valuable substitute for bronzes and other bearing materials.

Its good resistance to sliding wear under lubricated conditions has brought s.-g. iron into successful use for cylinder liners. Moreover, it is fully responsive to "Sulphonuz" treatment by which resistance to wear may be greatly increased. It can also be given the brown, or dark-matt surface required to minimize reflectivity in the metal parts of sporting guns and rifles, such as the breech casing shown in Fig. 15.

The resistance of s.-g. iron to corrosion may be regarded as approximately that of grey iron and this, in conjunction with its ductility, opens up a wide field of application, especially at sea, where it has proved itself suitable for ships' valves and other side and deck fittings, and for deck gear; propellers of various sizes are also in use. Where the properties available are fully utilized, these propellers can be of highly efficient design, and they lend themselves to protection by cathodic means. One s.-g. iron propeller, so protected, is now in use on the Tyne-Thames service with its performance under interested observation.

Centrifugally-cast Pipe

The combination of strength, ductility and resistance to mildly corrosive conditions has brought centrifugally-cast s.-g. iron pipe into large-scale production. Like steel tube, it can be used with safety at high pressure and will not fracture from rough handling or subsidence, but it has much better inherent resistance to the corrosive conditions likely to be met in service. When used to replace cast iron for conveyance of gases, it can operate with perfect safety at much higher pressure and the pipe can be of smaller diameter and lighter section. Moreover, in some cases, high-pressure conveyance can eliminate the need for gas holders on a long main. The joints can be made at minimum cost by tapered gas thread and the pipe so assembled is amazingly flexible (Fig. 16). Also, the assembled pipe can be bent as required and on site as shown in Fig. 17. Furthermore, all assembly and preparation of the pipe-line can be effected above ground and long stretches of pipe then lowered into the narrow trench, all with maximum convenience and minimum effort.

Other Fields

Its weldability facilitates repair and the preparation of assemblies in s.-g. iron or composites with other materials, such as high-pressure valves used for conveyance of sulphur dioxide, and which have stainless-steel seats welded in. The advantages inherent in making a casting to replace a forging or stamping are likewise very real. The item is usually closer to required dimensions, with resultant saving in machining, and improved design is made possible as, for example, by replacement of solid crankshaft by a hollow shaft, such as that shown in Fig. 18, or as pointed out by Daimler-Benz*, the improved connecting rod illustrated in Fig. 19, which has its

* British Patent Specification No. 724,067.

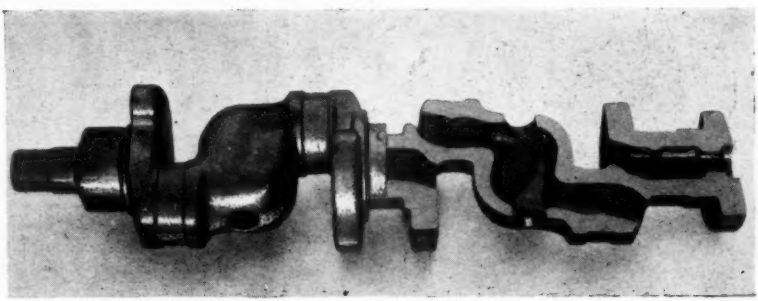


FIG. 18.—*Hollow s.-g. iron crankshaft used in German Ford Company's "Taunus" car.*

central web in the plane containing the axes of the bearings, and the ribs at right angles thereto.

Use of s.-g. iron constantly increases in heavy machinery, for the frames and other components

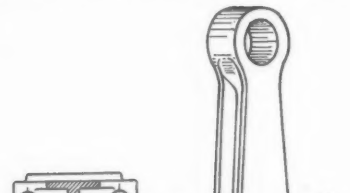


FIG. 19.—*Daimler-Benz design of connecting rod for manufacture in s.-g. iron.*

of hammers, presses, shears, punches and benders. It is also in expanding use for dies and tools used in the forming of sheet metal and the production of stampings and forgings. The mining and allied industries are also using it with success and a notable and recent South African casting of interest in this field is shown in Fig. 20.

Moulding Methods Applicable

The castings which serve to illustrate this Paper

FIG. 20.—*Bottom shell of the Kennedy gyratory crusher. Weight of fettled casting, 21½ tons.*
(Courtesy, Vanderbijl Engineering Corporation Limited, Union of South Africa.)

were made using green-sand, dry-sand, oil-sand and CO_2-bonded moulds and cores; resin-bonded shells and metal moulds. Successful use is also made of precision moulds with plaster and refractory investments. Indeed, it can be said that any moulding method is applicable to s.-g. iron and that there is no casting which cannot be made in it.

Spheroidal-graphite iron is now in use on road and rail, at sea and in the air, in electric motors, in petrol, oil, steam and gas engines, in steam and gas turbines and other power units which cannot be detailed. It does duty in forest, field and factory from the Arctic to the tropics and there is no major industry not already using it. All this in only a few years, but no more than "the end of the beginning" for this fascinating metal.

Acknowledgment

The Author thanks the Mond Nickel Company, Limited, for permission to publish this Paper and his colleagues and associates in many countries for direct and indirect assistance in its preparation. (When this paper was presented to the London branch of the Institute of British Foundrymen, the Author exhibited a number of specimen s.-g. iron castings to the audience and also a film entitled "Cast Iron that Bends." At an interval during the meeting, test-rigs were operated to show some of the outstanding properties of the material.)

REFERENCES.

[1] Braidwood, W. W., and Busby, A. D. "Spheroidal-graphite Cast Iron," *Nickel Bulletin*, 1949, **22**, 126–136; see also FOUNDRY TRADE JOURNAL, 1949, **87**, 327.

[2] Braidwood, W. W. "Spheroidal-graphite Iron Up-to-Date," FOUNDRY TRADE JOURNAL, 1952, **92**, 325–329; 361–366; and disc., 393–394.

[3] Braidwood, W. W. "Progress of Spheroidal-graphite Iron," FOUNDRY TRADE JOURNAL, 1953, **94**, 231–236.

[4] White, W. H., Rice, L. P., and Elsea, A. B. "Influence of Silicon Content on Mechanical and High-temperature Properties of Nodular Cast Iron," *American Foundrymen's Society Preprint* **51 - 5**, 1951; 9 pp.

[5] Berdyanskaya, M. G., Tsymbal, A. G. and Adamski, V. A. "An Experiment in the Production of Cast Iron with Nodular-graphite at the Red Star Foundry," *Sel'khozma hina*, 1951, No. **5**, 23–27.

[6] Longaretti, C., and Noris, M. "New Process for the Industrial Production of Nodular Cast Iron with Low Treatment Cost," *Fonderia Italiana*, 1952, **1**, No. 1, 3–9.

[7] Marincek, B. "Beitrag zur Herstellung von Gusseisen mit Kugelgraphit," *von Roll Mitteilungen*, 1951, **10**, 14–44.

[8] Wittmoser, A. "Gedanken zur Einordnung der Eisen-Kohlenstoff-Gusslegierungen," *Giesserei*, 1955, **42**, 573–580.

[9] Everest, A. B. "Spheroidal-graphite Cast-iron Dies and Tools for the Sheet-Metal Industries," Sheet and Strip Metal Users' Technical Association. Special Conference on Modern Materials. Advance Copy; *Sheet Metal Industries*, 1955, **32**, 805–812; disc., 825–828, 830.

[10] Williams, R. C., and Lownie, H. W. "The Case of the Absorbed Oxygen," *Modern Castings* and *Amer. Foundryman*, 1955, **28**, Aug., 58–60.

[11] Evans, E. R. "Thermal Shock—Some Experiments with Cast Iron," B.C.I.R.A. *Journal of Res. and Dev.*, 1955, **5**, 643–654.

[12] "Anti-Friction Properties of Spheroidal-graphite Cast Iron," FOUNDRY TRADE JOURNAL, 1951, **99**, 743–744.

THE IRONFOUNDERS NATIONAL CONFEDERATION announces that its annual general meeting will be held on June 20, at 2.30 p.m., preceded by luncheon at 12.30 for 1 p.m., at the Great Northern Hotel, King's Cross, London, N.1. Attention of members is drawn to a general meeting on June 6, of the North Western branch of the Confederation, commencing with luncheon at 12.30 for 1 p.m., which will be followed by a visit to the exhibition of s.-g. iron castings at the Midland Hotel, Manchester.

Dimensionally-accurate Castings*

By J. Hill

(*Continued from page 300*)

Core Uniformity

Many of the observations made upon mould uniformity and sands apply equally to core uniformity, though it is probably more difficult to obtain a uniformly-dimensioned core than a uniform mould. Core sands are subject to expansion and contraction during drying or baking, they have to be handled both in the green- and dry-condition, and must withstand the action of molten metal, but also collapse easily.

Wide developments have been made in coreblowing practice for large-quantity production of light and medium cores in oil-sand. There are many types of coreblowing machines available varying from the small, cartridge-type bench coreblower to the large automatic and semi-automatic machines. The basic principles are the same—sand is introduced into a corebox by air under pressure. By suitable choice of sands, control of blowing holes and vents from the corebox, very accurate cores of consistent-rammed density can be made. A feature of coreblowing is that the fine grains are usually blown to the surface of the core, the larger grains are left in the centre, and the result is a highly-permeable core with a fine skin.

The best blowing conditions are usually obtained from a free-flowing sand, with the result that these sands usually exhibit a lower green-strength than those used for hand ramming; in many cases this entails the use of specially constructed core carriers, and care should be exercised in their manufacture, since incorrectly designed or distorted carriers are a frequent source of dimensional inaccuracy. For general core production using oil-sand, a considerable step forward in maintaining accuracy has been made by the introduction of starch or dextrin binders, giving a high green-strength, but low hot-strength. By a controlled blending of oil and cereal the required green-strength and dry-strength can be obtained, very often eliminating the necessity for using costly core carriers, whilst maintaining a close control over dimensional accuracy.

Large cores made either in dried moulding-sand or oil-sand demand great care in the placing of grids or reinforcing rods which are subject to expansion both on drying the core and during the pouring operation. The resistance offered to a casting when contracting on to a core of this type, is often sufficient to crack the casting and provision has sometimes to be made to extract or break the core irons during the cooling of the casting. The drying of cores irrespective of type should be subject to close control. Many cases of dimensional inaccuracies in castings can be attributed to incorrect drying. Quick drying of dry-sand cores will result in spalling and cracking whilst the centre remains wet. Insufficiently-baked oil-sand cores may continue to bake after pouring, developing further strength, which will affect the casting dimensions and may even result in tears and cracks. Because of the tendency of cores to sag, careful inspection should always take place, and where close-dimensional accuracy is required, it is usual to jig any section where inaccuracies may occur.

When jointing is necessary, each half of the core can be made with an excess of sand on the joint. After drying, the core can be placed in a jig and excess sand removed by rubbing or by a core-milling machine. Jointing of cores can be carried out with gum or paste, but frequently this method does not give the accuracy required, and jointing is effected by dowelling with molten lead or with metal insert pieces. A useful method is to ram resin-bonded sand into the dowel cavity and then insert a hot wire which quickly cures the resin, forming an effective dowel. For some cores plaster of Paris or quick-setting cement can also be employed. When both moulds and cores are covered with a refractory coating, care should be taken to ensure a mixture of consistent viscosity, and great care should be taken in applying the coating, since dimensional variations often occur from this source.

MOULD PRESSURES, GATING AND FEEDING PRACTICE

Although mould and core uniformity, together with contraction characteristics, are probably the greatest factors in determining the ultimate dimensional accuracy of a casting, mould pressures developed during pouring and the gating and feeding practice can very much influence the ultimate size. The most important factor to be considered is the pressure exerted by the momentum of the moving body of metal, which is a function of the size, shape and arrangement of ingates coupled with the height of the static head.

An example of the effect on dimensions of the resistance to the momentum at the end of the pour was shown when moulds for a tractor axle weighing 80 lb. (Fig. 13) rammed to a given mould hardness were poured in 13 seconds, and 17 seconds by varying the ingate dimension. It was found that the resultant casting from the moulds poured in 13 seconds were 4 to 5 lb. heavier than those poured in 17 seconds, the work done in enlarging the cavity of the mould being provided by the kinetic energy in the moving body of metal. The increase in weight was spread evenly over the body of the casting resulting in a thicker section.

* Official exchange paper from the Institute of British Foundrymen to the Australia (Victoria) branch on the occasion of its annual conference. The Author is development engineer, Ley's Malleable Castings Company Limited.

Dimensionally-accurate Castings

Local gains can be observed around an ingate, especially when concentrated upon one part of the mould, resulting from pressures created by frictional resistance during pouring, and resistance to momentum at the end of the pour; although it is not always possible, it is good practice for the metal to enter at different parts of the mould. Pressures in moulds during pouring are built up by the compression of air, the evolution of gases, and, in green-sand castings, the evolution of steam. The rate of formation and removal of these gases is important and is affected by the speed of pouring. Gating and feeding affect dimensions by the creation of local hot spots which affect contraction; careful study should be made to disperse these points. Incorrectly positioned gates and risers can also act as ties, resulting in hindered contraction.

EQUIPMENT

Moulding Machines

Mention has been made of the ramming characteristics of the machines generally employed; there are, however, other considerations which determine the choice of machine for making a given casting, perhaps the most important of which is the method of pattern draw. In determining the type of moulding machine to be employed, many factors are involved which are not exactly within the scope of this Paper, production considerations perhaps being the greatest.

Some of the advantages of obtaining dimensional accuracy when using moulding machines, such as consistency in ramming, have already been mentioned; another advantage is the moulding of all runners, risers and ingates, the importance of which has already been stressed. Mould accuracy from pattern drawing is greatly increased, and patterns have a longer life. The most common methods employed for withdrawing the pattern from the mould are:—

(1) With the simple squeeze or jolt/squeeze machine using a loose patternplate, the box and plate are turned over manually, and the plate extracted manually from the mould using a mechanical vibrator on the plate.

(2) The box is pushed off the pattern, the pattern remaining in a stationary position.

(3) The box and pattern are lifted from the jolt position, the box is then locked on an apron frame, and the pattern removed by dropping to its ram position.

(4) The box and pattern are made to turn through 180 deg. and the pattern withdrawn upwards from the mould.

(5) The box and pattern are made to roll outwards through 180 deg. and the pattern withdrawn upwards from the mould.

(6) With the employment of a stripping plate.

All the machine methods are more accurate than the manual withdrawal of the pattern, since this is dependent upon the skill of the operators and offsets can also be caused by careless turning over. Where deep lifts are involved, the turnover machine is employed and in removing the pattern from the mould in this manner, the greatest accuracy is obtained. However, under circumstances of maintaining accuracy with optimum production speeds, the choice of a suitable sand cannot be ignored, and it is very often found that with the more highly-bonded synthetic sands, the same degree of accuracy can be obtained with the straight-draw type of machine.

It has been the Author's experience that the most accurate of the straight-draw machines are those employing the apron frame, as the stripping action, as distinct from pushing off, appears to give less disturbance to the mould. Another advantage, and perhaps the most important, is that if the moulding box has been rammed at a slight angle, it will not

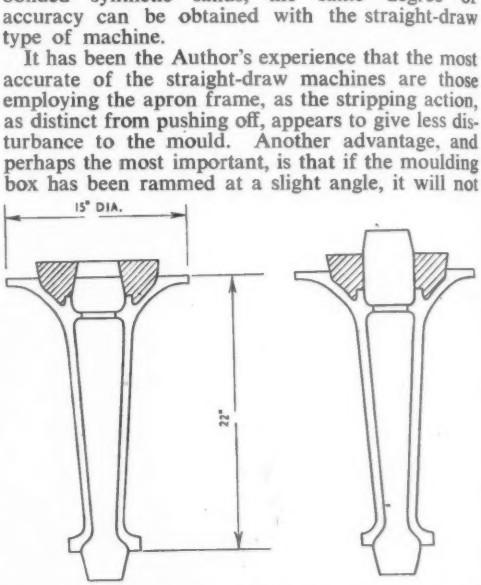


FIG. 10.—*Alternative methods of coring an 80-lb. axle-case casting.*

affect the relationship between the pattern and the mould when the pattern leaves the mould. Under the same circumstances, pushing off on pins from four corners of a moulding box will affect this relationship and could result in a dropped mould. The difference between the two types of machines is, however, only noticeable where deep lifts are encountered, or if the pattern has little taper. If these considerations are not involved, there is little to choose between the two machines.

Probably the most accurate method of removing a pattern from the mould is by a stripping plate which follows the contours of the mould and supports the joint face, the pattern being withdrawn through the plate. But the pattern equipment for this type of plate is costly and can only be warranted when very high outputs from one pattern are involved. However, the principle can even be applied to maintain accuracy with loose pattern work by placing weighted or fixed guides on the joint which will hold the pattern in a rigid position.

When supplying sand to moulding machines from overhead hoppers, the direction of fall of the sand should not be ignored, as with some moulds,

especially those of a pipe section, sand falling into the moulding box tangentially to the pattern can be a source of " ram-offs."

Patterns

The amount of money and time which can be economically expended upon pattern equipment is dependent on the degree of accuracy required and the number of moulds to be produced from a given pattern. For large jobs where few castings are required, wooden patterns are essential from considerations of weight and easy working, and they may even take the form merely of skeleton or strickle equipment. The degree of accuracy obtained from these methods is often dependent upon intelligent co-operation between the pattern shop and the foundry in determining the position of joints, cores and drawbacks, coupled with a practical knowledge of points where inaccuracies are liable to occur.

Much thought and practical experience has resulted in a range of methods being employed for the manufacture of pattern equipment to give

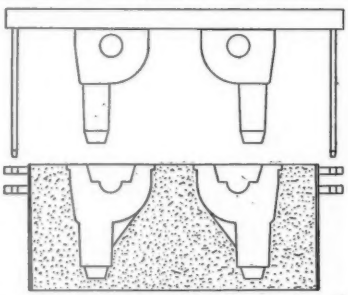


FIG. 11.—*Cross section of jig for setting the cores of two rear axles with the bore downwards.*

maximum accuracy with minimum cost. Small and even quite large patterns both wood and iron are mounted on wooden boards, and this latter method could possibly be more widely extended, especially for use in conjunction with impeller rammers. Plaster and pattern cement are used both for patterns and for the mounting of metal patterns which in many cases give a remarkably long life.

The making of metal-pattern equipment for production moulding has now become a skilled trade in itself and in this respect the value of pattern drawings giving profiles and sections cannot be over-emphasized. Too often this aspect is left to the individual skill of the patternmaker and variations due to a patternmaker's interpretations of a section are frequently found.

Thought should be given to the taper on patterns; minimum taper does not always give the degree of dimensional accuracy required, since " ram-offs " may occur, due to the ramming pressure of the higher layers of sand forcing the compacted sand away from the pattern at joint level, so forming a mould slightly larger at the joint.

Recently there has been the development of the pressure-cast aluminium plate. This can be a very cheap method of producing an accurate pattern plate requiring only one master pattern which is duplicated in a plaster mould, aluminium then being poured under pressure. Very little if any finishing is required to the cast plate. The technique of making pressure-cast plates has become widespread in the USA, and it is interesting to note that this has had a marked effect upon their production methods for small castings, where even on highly mechanized plants the simple jolt/squeeze hand-pattern draw machines, coupled with flask moulding, are widely employed, resulting in a high degree of dimensional accuracy with high-production speeds and low pattern costs.

An important point when making a pattern using cores is to ensure as far as possible that a core is registering in a moulded print. Inaccuracies creep in, and are liable to be repeated, if a dried core is inserted into a mould and the same core is then used as a print for a further core (Fig. 10).

Jigs and Gauges

The insertion of a core in a mould is always a potential source of inaccuracy, and adequate prints should always be provided, both for location and to ensure that it is held firmly against the tendency of the molten metal to displace it. To ensure accuracy it is sometimes necessary to use gauges when placing cores and then to prevent displacement by the use of metal studs, chaplets or external mechanical means. Studs and chaplets should be regarded as precision tools and care should be maintained to check their accuracy. They should also be sufficiently strong to withstand the mould pressures.

Where a very high degree of dimensional accuracy is required for heavily-cored work, made at high speeds, as in the production of automobile cylinder blocks, precision jigs are employed in which the whole core assembly, having been previously jigged in the core shop, is placed and lowered into the mould on pins. By using this method, speed and accuracy are combined. It frequently enables the use of " blind " or unsighted prints, and allows the mould joint to be made in the manner most economical for production ; or for the most efficient gating and feeding practice, which might not have been possible had it been necessary to sight the core into the print. Fig. 11 shows diagramatically a jig for coring two rear axles with the bore downwards.

Pattern Pins and Holes

On mass-production work demanding a high degree of accuracy, a careful control of pin and pin-hole clearances and wear should be carefully noted. In determining limits of wear, its effect should be carefully assessed. For example, with single-sided plates, each making a half mould, and employing loose closing-pins, the following effects have to be considered. (N.B.—In considering these effects, the standard pin-hole diameter is taken as a datum.)

Wear on Pattern Pins.—The maximum possible offset is half the difference between the standard set for the box-pin hole and the pattern-pin diameter for each half mould. That is, if the standard for

Dimensionally-accurate Castings

the box-pin hole is 0.755 in., taking this figure as a datum, if the pattern-pins have worn to 0.745 in., *i.e.* 0.10 in., the maximum offset from centre line of one half box will be 0.005 in. If the pins on the other half have worn by the same amount, the maximum total offset from centre-line will be 0.10 in.

Wear on Closing Pins.—The maximum possible offset from closing-pin wear will be equal to the difference between the standard and the undersize dimension.

Box-pin hole wear.—Box-pin hole wear can produce a double error. When ramming the box, the error produced is in effect the same as when using an undersize pattern-pin, and when closing the effect is similar to an undersize closing-pin.

Variation in Pin Centres.—When setting close allowances between pin and pin-hole, it is necessary to give careful attention to pin centres which can vary with the temperature of the moulding box. This is overcome by using round and elongated holes for the pins.

It will be noticed that wear in pin holes can produce twice the dimensional error of that from closing-pins and four times that from pattern-pins. As pin-hole bushes are difficult to fit, and also account for the greatest error, it is better that most wear should occur on the pins. However, whilst pattern-pins and closing-pins are used for each mould, the moulding boxes are used less frequently and hardened-steel bushes and pins of similar material appear to give the best general results, although these are varied to suit peculiar conditions.

Method of Setting Limits of Wear

As well as wear, other factors such as " ram-offs " can cause dimensional error. Limits on wear should be set under the figure of maximum permissable offset. For example, if a maximum offset in a casting is given as 3/64 in. (0.047 in.) and it is decided that pin wear can take up to 0.040 in. offset, limits can be calculated as follows:—

Pattern-pin wear of
−0.010 in., max. offset = 0.010 in. (0.005 in. cope + 0.005 in. drag)
Closing-pin wear of
−0.010 in max. offset = 0.010 in.
Box-pin hole wear of
+0.010 in., max. offset = 0.020 in. (0.010 in. ramming, 0.010 in. closing)
Total offset = 0.040 in.

It will be appreciated that these figures give maximum possible error and that frequently a positive error will cancel a negative error ; wider limits can be allowed if in practice the odd occasion when all the wear becomes effective is accepted.

It should also be noted that when employing loose closing pins, the box-pin holes should be as near to the joint as possible. A further error can occur by the closing-pins falling over from a vertical position if the pin holes are wide apart.

The example quoted is for fixed pattern-pins and loose closing-pins, a method which has been widely developed on mechanized moulding systems. Careful thought should, however, be given to fixed pins in the drag half of moulding boxes. These can be

FIG. 12.—*Gauging of an axle-case casting.*

in the form of strut pins, of just sufficient length to ensure accurate assembly, and a long, tapered pin which can be inserted into the end of the strut pin for mould assembly. The effects which have to be considered in this case are as follows:—

(1) Wear of pattern-pins (cope pattern).—The maximum possible offset is half the difference between the standard set for the box-pin hole and the pattern-pin diameter.

(2) Wear of pattern-pin holes (drag pattern).—The maximum possible offset is half the difference between the standard set for the pattern-pin hole and the actual diameter of the pattern-pin hole.

(3) Wear on box-pins and pin holes.—(*a*) The effect when ramming the box is that produced by an undersize box-pin or an oversize box-pin hole; (*b*) the maximum possible offset when closing is half the difference between the box-pin and the box-pin hole diameter.

For example, allowing a pattern- and box-pin wear of 0.010 in. and pattern and box-pin hole wear of 0.010 in., maximum offset from pin and pin-hole wear will be as follows:—

Pattern-pin wear of −0.010 in., max: offset = 0.005 in.
Pattern-pin hole wear of +0.010 in., max. offset = 0.005 in.
Box-pin wear of −0.010 in., max. offset = 0.010 in. (0.005 in. ramming, 0.005 in. closing)
Box-pin hole wear of +0.010 in., max. offset = 0.010 in. (0.005 in. ramming, 0.005 in. closing)
Total offset = 0.030 in.

It will be noticed that in the examples quoted, in which the same allowance between pin and pin holes has been allowed, the fixed-pin method shows only three-quarters of the error of the loose-pin method. This figure is not necessarily a constant, and what in effect happens is that the inaccuracies resulting from the allowances on the loose closing-pin have been eliminated. Other considerations apply equally to both methods.

PHYSICAL CORRECTION AND INSPECTION

Physical correction is sometimes necessary to ensure an accurate product. Fettling could be included in physical correction and much can be done

in this respect by eliminating undue flash in the foundry. Some castings in blackheart-malleable iron and some steel castings distort in annealing and have to be pressed back to shape. For blackheart malleable castings for the automobile industry, use of accurate and expensive dies are involved, but it should always be remembered that a casting can only be pressed back to the dimensions obtaining before the distortion occurred.

With large numbers of castings or with a complicated design, it is desirable that the founder should have a first-operation jig or gauge similar to that of the machinist. This jig or gauge can usually be made in a more simple and less expensive manner than the original, and the use of it will result in a smaller number of rejects and a more satisfied customer. With specialized machine set-ups, simple equipment can often be made to check the main feature of the castings, such as core positions, freedom from distortion, etc. Fig. 12 shows an axle-case casting being gauged before despatch, using a fixture which duplicates the machining set-up as far as possible and tests the squareness of the flange and the concentricity of the bores.

When the important dimensions and the degree of accuracy are known, suitable jigs, gauges or templates should be provided to check castings. This is frequently done with large orders, but even with small orders, suitable equipment can be provided at small cost, *e.g.* plywood or sheet metal templates, welded calipers, simple plugs, etc.

CASTING DESIGN

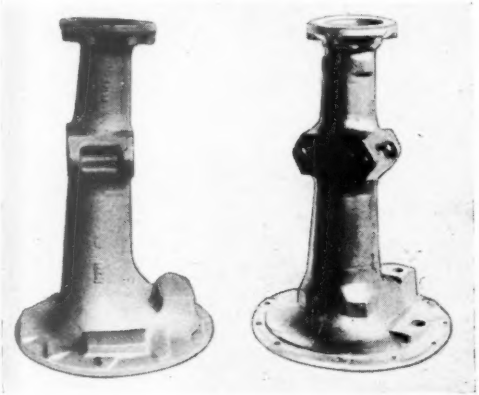
Many of the founder's difficulties lie in the fact that sensible tolerances on important dimensions are rarely specified, with the result that unimportant dimensions are sometimes held to close limits, whilst important ones are neglected. By consulting the founder on the design of the casting at the earliest possible moment, the purchaser can indicate the important dimensions, especially regarding jig locations and machining methods, in order that the same data may be employed. It is good practice to incorporate bosses or pads as an integral part of the casting for jigging purposes. If possible these should be part of the mould.

Fig. 13 shows an axle-case casting for which special purpose automatics were built around locations difficult to work in the foundry. The original locating jaws made contact at one end on the curved development of the body not easily machined accurately on the patterns, and at the other end, under the small flange on the portion which is tapered and eccentric. The machining of initial supplies showed that minor variations in body form due to patterns or casting gain, as well as variations in length, adversely affected the general machining position, particularly as the jaws only provided a relatively small base area; special machining pads were indicated and were added, as shown on the right-hand casting, where they would coincide with the original jaw positions. Gauging was carried out as described in Fig. 12.

The founder can indicate from his experience the dimensions with which he anticipates difficulty. Often the founder can suggest minor modifications which will eliminate trouble later, *e.g.*, circular bosses at given centres may be elongated and adjusted after sample castings have been made. Flange diameters may be made oversize and reduced after trial. Such adjustments are costly but cheaper than new patterns. Where larger quantities of castings are required, a greater degree of accuracy may be obtained after such alterations, and with single castings, precautions such as these may often save costly rectification or wasters.

When a design is for a small number of a single casting which will be " lined out " before machining, it is important that the founder should know the datum lines the machinist intends to employ. This will enable him to check patterns, core setting, etc., from the same data.

FIG. 13.—*Location of machining pads on two axle-case castings.*



GENERAL CONCLUSIONS

In writing a Paper of this type the difficulty is neither to over-generalize nor to over-emphasize one particular aspect. An attempt has been made to stress the most important phases where inaccuracies occur and by suitable references and the Author's own experience to give some detail which will be of practical interest. The whole theme is that accuracy must be associated with control. It would be a very good thing if the purchaser would state the degree of accuracy required when making an enquiry, in order to ensure that the founder will be able to make equipment to suit. Patterns supplied by the customer, should be checked on receipt to see if they are suitable.

It has been stressed that if very close dimensions are required the use of standard contractions are precluded, since factors will often produce variations which can be remedied only by trial and error, even if there is a complete knowledge on the founder's part of the contraction characteristics of his metal, combined with a wealth of experience as to modifications due and the effects of shape and section. To

Dimensionally-accurate Castings

reproduce accurate results standard conditions must be adhered to as closely as possible. For any given method, therefore, the dimensional accuracy depends on the degree of control that can be economically applied; however, it is essential that in determining the degree of control, the mechanics and chemistry of the processes involved are fully appreciated.

Over the past few years, much wider developments have taken place in precision-casting processes in the foundryman's efforts to supply the engineer with a better product, and to produce castings to near machined tolerances in metals not easily machined. An excellent survey of current methods has been made by the editorial staff of *Materials and Methods*.[11] The development of the CO_2 process for dried cores and moulds appears to be offering possibilities of closer dimensions for general work.[12]

Some of these processes are opening up new fields or showing improvements in old ones. Basically many of the processes attempt to eliminate the variables present in green- and dry-sand moulding. Whilst this may be possible, many of the variables such as contraction still remain or may be accentuated. It may well be that if the same degree of control and expenditure on pattern equipment to make the necessary compensations for these variables were applied to green-sand moulding, comparable results could be obtained.

Acknowledgments

The Author would like to thank the directors of Ley's Malleable Castings Company Limited for permission to publish the Paper and his colleagues for assistance in its preparation. Acknowledgment is also made to the publishers of "Modern Foundry Practice" for the incorporation of certain short abstracts.

REFERENCES

[11] Anon, "Close-tolerance Castings," FOUNDRY TRADE JOURNAL, 115 (Feb. 3, 1955).

[12] A. Talbot, "Cores and Moulds by the CO_2 Process," FOUNDRY TRADE JOURNAL, **98**, 559 (May 26, 1955).

Company News

SPECIALLOID, LIMITED—The dividend for the half-year ended May 15, 1950, on the £200,000 5½ per cent. preference capital is being paid.

CRONITE FOUNDRY COMPANY, LIMITED—The company is planning to issue one ordinary fully paid 5s. share for every ordinary 5s. share held.

GASKELL & CHAMBERS, LIMITED, engineers, brassfounders, etc., of Birmingham—The company states that an application is being made to the Capital Issues Committee for permission to make a rights issue on favourable terms.

BABCOCK & WILCOX, LIMITED—An increase of over £620,000 to £4,728,418 in the group profits is shown in the preliminary statement for 1955. The dividend on the £7,524,398 ordinary capital is maintained at 15 per cent., less tax, with an unchanged final payment of 8 per cent.

HARRISON (BIRMINGHAM), LIMITED, machine-made brassfounders, metal rollers, etc.—A 100 per cent. scrip bonus for holders of the £198,000 ordinary capital is proposed by the board for 1955. Moreover, as in the previous year, a dividend of 25 per cent. and a bonus of 5 per cent., both tax free, are recommended.

HUNT BROS. (OLDBURY), LIMITED, engineers and ironfounders, of Oldbury (Worcs)—The company is awarding a final dividend of 17½ per cent. for 1955, making a total of 22½ per cent. for the year, compared with 25 per cent. in the previous year. Group trading profit amounted to £64,692, against £64,400 for the year before.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED—A final dividend of 9 per cent. is recommended for 1955 on the £4,875,000 ordinary stock, making 11½ per cent., less tax, for the year against 10½ per cent. in 1954. A year ago holders also received a special 2 per cent. capital profits distribution, not subject to tax.

BORAX CONSOLIDATED, LIMITED—It is proposed to form a new American operating company to carry on activities in the United States and to transfer the activities outside the US to a new subsidiary in the United Kingdom. Borax Consolidated will therefore become a holding company, owning shares in the British and overseas subsidiaries.

HERBERT TERRY & SONS, LIMITED, spring and press-work manufacturers, of Redditch (Worcs)—The company is raising its total distribution for 1955 by 2½ per cent. to 15 per cent., with a final of 5 per cent. (the same) and a bonus of 7½ per cent., against 5 per cent., on the £600,000 ordinary capital. Net profits have risen from £107,786 to £140,887, after tax of £152,004 (£102,893).

FLETCHER, HOUSTON & COMPANY, LIMITED, ironfounders and engineers, of Tipton (Staffs)—Shareholders accepted on provisional allotment letters 553,289 (or 97.1 per cent.) of the 570,000 1s. ordinary shares issued at 5s. per share. Applications for excess shares have received allocations on the following basis:— 1-80 shares, in full; 81-550, 80 shares; 551-4,000, 100 shares. One applicant for over 4,000 shares was allotted 121 shares.

BRITISH ALUMINIUM COMPANY, LIMITED—Arrangements are now in hand for the rights issue by the company. The 2,000,000 £1 ordinary shares, it is understood, will be offered to existing holders at a price of 40s. each on a two-for-five basis. The £4,000,000 is needed in connection with the new Canadian aluminium smelter. Approximately £7,000,000 is required for the first stage of this project of which £3,000,000 will be in UK bank loans—probably to be funded during the three- to five-year period of accommodation by loan capital.

NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED—Exports of railway locomotives have been so badly hit by competition from Japan and "Iron Curtain" countries that it is "surely a matter for Government intervention," said Mr. T. A. Crowe, chairman, at the annual meeting. He added that recently India asked for prices for a large number of locomotives. The UK price was £38,870 each, a figure which contained virtually no profit. The price from Japan, however, was £30,500, while those from Poland, Hungary, and Czechoslovakia ranged from £31,350 to £31,862. Net profit of the company last year dropped from £213,132 to £125,592. The order-book was at present reasonably well filled, said Mr. Crowe.

Equipment and Supplies

Continuous Sand Mixer

For many years, the American subsidiary of Baker Perkins, Limited, of Westwood works, Peterborough, have marketed continuous sand mixers of large capacities and unusual design, and manufacture has now been commenced in this country by the parent company. These mixers can deliver mixed sand of controlled properties in an uninterrupted flow at rates up to 120 tons an hour. It is claimed they are used extensively in motor-vehicle foundries in the United States, one large grey-iron foundry, for instance, uses a batch of six machines, producing in aggregate over 17,000 tons of sand per three-shift day.

These machines (Fig. 1) depart from the conventional method of pan mixing, where working parts are sometimes exposed. The B.P. mixers are totally enclosed, and consist essentially of two spindles with Sigma-type blades which rotate side by side with small clearance in a closely fitted trough. The mixers are usually fed with sand from a rotary platform, receiving its supply in turn from a main hopper, the amount fed to the machine being governed by an adjustable skirt at the hopper base. A series of smaller hoppers can be arranged to supply bonding materials and other additives. The machines are truly continuous, being designed specifically with that end in view.

Proving Tests

When it was decided that the parent company should manufacture these mixers, it was decided first to instal a small mixer with a capacity range of 7 to 15 tons per hour in their own foundry. Here, performance was observed under typical foundry conditions and a variety of field tests was carried out. This model

FIG. 1.—*Continuous sand mixer of large capacity, manufactured by Baker Perkins, Limited.*

of the mixer is about 8½-ft. long by 3½-ft. wide and the drive is about 5½ ft. by 2 ft. Spur gearing is used for transmitting the drive from one spindle to the other and forced grease-lubrication is supplied to all points from one central pump. The drive is at present effected by means of a variable-speed d.c. motor, driving through a Radicon reduction gear, although it could be effected with an a.c. squirrel-cage motor and a variable-speed gearbox coupled with the reduction gear. Alternatively, if only one speed of operation were required, a straight a.c. squirrel-cage motor and reduction gear could be used. A Twiflex clutch is incorporated between the mixer and the prime mover which serves to protect the motor and gearbox in the event of the mixer becoming jammed, and also eliminates high torques if the mixer is started up when full of sand. The mixer blades are removable to facilitate easy cleaning and also slotted to allow a radial movement for adjusting the clearance between the blades and the side of the mixer.

During the tests carried out in the Peterborough foundry various graphs of h.p. and output against mixer speed were compiled. The mixed quality of the sand appeared to be very good at all outputs (from 7 to 17 tons per hour); the mixer required approximately 28 h.p. to operate at 16 tons per hour, dropping to 19.75 h.p. at 7 tons per hour. (A large mixer of this type, when producing 45 tons per hour, requires 75 h.p., giving a ratio of 1.6, and the largest size, producing 100 tons per hour, requires about 100 h.p.) On test, sand remained within the mixer trough without spilling over the sides and it was possible to keep the floor entirely clear of sand, thus making for very clean working. For this model, the retention time of sand in the mixer at an output of 10 tons per hour, was found to be 1.86 minutes, the composition being approximately 88 per cent. knock-out sand, new sand 6 per cent., Fulbond 4 per cent. and pelleted pitch 2 per cent. The permeability of the mixed sand was between 100 and 150 and the green strength from 5 to 7 lb. per sq. in. at a moisture content of approximately 3.5 per cent.

A feature of the design is that although inlet and outlet openings of the mixer are of equal area, a sliding gate is fitted to the outlet which may be adjusted slightly in order to increase or decrease the retention time as desired. Moisture control is at present effected by hand, but it is hoped later to develop an automatic system for this purpose.

Wire-rope Terminals

Tulcon wire-rope terminals are a recent development of the Tulloch Construction Company, Limited, Farringford House, 70, Brighton Road, Sutton, Surrey. The terminals consist of compact assemblies of three simple units which, when assembled, form a terminal locking the wire rope to the assembly and forming a connection that, it is claimed, cannot come apart. The assembly consists of a sleeve, to accommodate a given size and diameter of wire rope; a plug, which is inserted to separate and hold the strands of the wire rope; and a terminal which can be made to suit any given application. The sleeve and the terminal are made of forged alloy-steel and the insert of shell-cast gunmetal. As a result the complete assembly provides a strong terminal designed to exceed the strength of the wire rope to which it is attached. It is said that the terminals can be attached within minutes, and a permanent attachment effected by unskilled labour using a hammer, spanner and vice. No heating of metal, welding or brazing is used.

New Welfare Centre

In the summer of 1954, Edgar Allen & Company, Limited, Imperial Steel Works, Sheffield, 9, decided to build a main welfare block to serve men employed in the steel foundry department, so meeting the requirements of the Factories Acts, 1937-1948, and the Iron and Steel Foundries Regulations, 1953, relating to the provision of accommodation for clothing and facilities for washing. After inspecting the available sites a decision was made to erect a building at first-floor level in U-shape form along the front and side elevations of the foundry moulding shop. The building was designed and constructed in reinforced concrete, the ground area being reserved partly for the bulk storage of moulding sand, the housing of an existing rotary sand-drying plant, a new main staircase to the ablutions block, and a building for the engineering services equipment serving the welfare centre.

On entering the centre from the main staircase, a heated drying room is provided with racks for outer clothing; next one enters the clean clothes locker room in which there are 508 lockers of the Miners' Welfare Committee type; connecting to this room are the shower-room and the ablution room which are equipped to the approved standard for the number of men using the building. On the opposite side of these sections is a locker room for the holding of working clothes with changing space adjacent; a staircase leads from this room direct to the works.

The surface finishing to all walls has been designed to conform to the most modern conception of industrial hygiene, with glazed tiling in the wash-room and shower-room, Muroglaze on brickwork, and Thermalite faces on cement-rendering to the height of window sills in other rooms. Continuous glazing runs along the entire frontage of the building. In the wash-room and shower-room, ceilings are treated with a special absorptive preparation to prevent condensation, while also in these rooms extractor fans are installed at a high level to control atmospheric humidity. Floor covering in all sections is in rock asphalt, with floors falling to drainage channels to facilitate washing and hosing down. Lighting is provided by fluorescent strip in the locker rooms and by flameproof bulkhead fittings in the ablution rooms.

The building is served by a Plenum heating installation; steel ducting is taken at high level to the welfare centre and delivers warm, filtered air to the various rooms and to the locker equipment. The system is supplied with a centrifugal fan which draws air through a rotary viscous filter of a self-cleaning type. The air passes through a gilled tube heater battery; and its temperature on leaving the battery is controlled through an automatic modulating valve fitted in the steam supply. A fumigator continuously disinfects the air as it passes into the system. Close attention has been paid to the atmospheric requirements in the several rooms, and allowance has been made for maintaining the various temperatures over a wide range of air changes per hour.

For providing steam to the hot-water service, calorifiers and the Plenum heating installation, a package-type, gas-fired boiler has been installed. This boiler is complete with all automatic controls, condenser tank, boiler feed pump, etc., and is fired on town's gas. The hot-water service consists of calorifiers with secondary flow and return piping to feed the showers, foot-baths and wash-troughs. The temperature of the water is controlled by a thermostatic valve in the steam supply. The cold-water storage tanks are

(*Continued at foot of col.* 2)

of high capacity and fitted in a tank room at roof level. Each shower cubicle is equipped with independent mixing valves with a shower-arm and minispray fittings and thermostatic mixing valves are provided for the wash-troughs and foot-baths. The locker equipment is fitted in nests to suit the layout, each locker being complete with a number, lock and key, and a superintendent's room is provided near the main entrance, equipped with key-rack, storage-cupboards, etc., so that efficient control may be maintained.

Aluminium Development Association

At the annual general meeting of the Aluminium Development Association, held at 33, Grosvenor Street, London, W.1, on April 20, the retiring president, Dr. H. W. Clarke, presided and introduced the report for 1955.

It referred to the outstanding event of the Association's year—the exhibition, at the Royal Festival Hall, in June, to mark the centenary of the first production of aluminium in Britain. This event, graced by a visit from H.R.H. the Duke of Edinburgh, absorbed a considerable portion of effort in the first half of the year but nevertheless a satisfactory measure of general progress was achieved. Good progress was made in the major fields of development, especially in building, marine, road and rail transport, and electrical engineering.

Among research activities was noted the continuation of various aspects of current structural research, also of fundamental investigations in the fields of road and rail transport. Information and educational services were especially active, partly as a consequence of the centenary exhibition and the enquiries it provoked for a considerable period afterwards. A total of 16 new and revised publications was issued in addition to four numbers of *The Aluminium Courier*, two of which dealt with the exhibition and its technical papers and discussions.

Honorary Officers

The Hon. Geoffrey Cunliffe was elected president of the Association for the ensuing year, and the new vice-president of the Association is Mr. Spence Sanders (Almin, Limited). Mr. J. H. Mayes (Northern Aluminium Company, Limited) was appointed chairman of the executive committee in succession to Mr. Harold Goodwin who had completed two years in this office. Mr. Cunliffe, who has served before as president (1945-6 and 1947-8), is deputy chairman and joint managing director of the British Aluminium Company, Limited, and chairman of Aluminium Corporation, Limited, and Aluminium Wire & Cable Company, Limited.

Iron and Steel Institute Meeting in France

The Iron and Steel Institute has accepted an invitation from the *Chambre Syndicale de la Sidérurgie Française* and the *Société Française de Métallurgie* to hold a special meeting in France from Tuesday, June 5 to Thursday, June 14. The *Chambre Syndicale* has undertaken the responsibility for the arrangements in France in collaboration with Dr. E. Dupuy (*Société Française*) and M. P. Gouge (*Société Métallurgique de Normandie*). The meeting will be divided into two sections —June 5 to 11 in Paris and June 11 to 14—affording opportunities for three alternative excursions to iron and steelmaking areas.

Notes from the Branches

Bristol and West of England

Following the successful meeting for apprentices held by the Bristol and West of England branch of the Institute of British Foundrymen at the beginning of the session, a further meeting was arranged for March 10 and drew a record attendance of 97 apprentices from the foundries, patternshops and laboratories of many firms in the Bristol branch area, many of the boys travelling from places as far apart as Stroud, Tiverton and Chippenham. The following films were presented after the boys had inspected the new model foundry at Bristol College of Technology, where the meeting was held:—"Moulding a Part having a Vertical Core"; "Making a Master Pattern and Corebox for a Water-cooled Motor Block" and "Foundry Practice," the first two being American and the last an English film.

The boys returned to their firms very anxious for further meetings of this type to be arranged—perhaps the luncheon which followed the meeting was an added attraction! It is gratifying, however, to note that many of the boys who have attended these two meetings for apprentices, have come along subsequently to ordinary branch meetings. Mr. D. A. Richards, the branch president, in thanking the boys for their support added the thanks of the branch to the Bristol College of Technology for having granted the facilities to hold these meetings. Many of the boys are attending courses at the College (a full description of the foundry and the training course appeared in the JOURNAL last autumn).

Exeter Meeting

A well-supported meeting was held at Exeter College of Technology on March 10, when by popular request, Mr. A. Talbot repeated his Paper on the CO_2 Process. Forty members and friends, most of them from Devon and Cornwall, were present to hear this very interesting lecture and the Author, at the close, was faced with many questions, indicating the great interest aroused.

In replying to the many questions, Mr. Talbot made the following points:—There was a pronounced reduction of fumes with CO_2-bonded sands; venting practice could be reviewed when using this new type of material, removal of air being of greater importance than gas removal; cores, when properly blacked with a spirit-bonded blacking, could be used when casting lead bronze and other metals of a very "searching" nature. No appreciable pick-up of moisture from the atmosphere was experienced even on allowing the treated moulds or cores to stand for several days. Questioned regarding the possibility of sand recovery, Mr. Talbot said that this was within the bounds of possibility, but much depended upon the economics of such reclamation.

It was, of course, not necessary to fill a mould with CO_2-treated sand, he said, normal backing sand could be used with a comparatively small section of treated sand being used around the actual casting face. There was little possibility of undesirable contamination from CO_2-treated sand by ordinary sand in a foundry where both were being employed. Mr. Talbot emphasised the necessity for using properly dried sand when making up the mixtures for sands to be CO_2 treated. When allowing for "camber" in a mould, he said that normal practice could be safely employed for CO_2-treated sands.

In proposing a vote of thanks to Mr. Talbot, Mr. A. Jackson said he regretted that question time could not go on longer, but as he was taking Mr. Talbot to the

(*Continued on p. 340, foot of col. 1*)

Group of foundry apprentices at the meeting arranged by the Bristol and West of England branch of the Institute. Also included in the picture are Mr. E. Poole and Mr. J. Bailey of the Bristol College of Technology (engineering department), Mr. F. A. Storey of the College staff, and Mr. D. A. Richards and Mr. G. W. Brown, the branch president and secretary respectively.

[Courtesy, "Western Daily Press" and "Bristol Observer."

Publications Received

Accidents—How they Happen and How to Prevent Them. Vol. 26; published by the Factory Department through Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2; price 1/- net.

It is pleasing to report that this issue contains no reference to foundry accidents. It discloses a method of adding alloys to ladles of liquid steel, but so far as foundries are concerned the chain-operated container over the cupola tapping spout is equally efficient and safe.

Survey of the Timber Trade, by Roland Grugeon and Jack Leigh; published by the Purchasing Officers' Association, Wardrobe Court, 146A, Queen Victoria Street, London, E.C.4; price 3s.

Patternmakers, reading this title, will probably imagine that here they will find material of direct interest for them. In this they will be disappointed as the subject matter is largely devoted to soft woods. Here this 24-page pamphlet is excellent and gives information as to the sources, preparation of the timber, the methods of sawing and the import snags, thereby providing a source of reference not too easily come by.

Giesserei—Kalender, 1956 (in German). Edited by Philipp Schneider, and published by Giesserei Verlag G.m.b.H., 27 Breite Strasse, Düsseldorf; price 3 D.M.

This foundry yearbook is presented to all members of the German foundrymen's association. The early part is much the same as would be found in the average English diary. Then follow formulæ for mensuration, conversion tables, physical constants, the composition of new materials and the like, a section running to about 80 pages. Technical notes covering many aspects of foundry practice, including standard specifications, occupies a further 140 pages. The reviewer found the next section most interesting, as it is devoted to statistics. Here one learns that the output of Western Germany is now approaching the pre-war production of the whole of the country. Another interesting table shows how the ratios of production of iron, steel and malleable castings have changed over the last decade to give the 1955 figures of 86.9; 8.6; 4.5, respectively, as against the 1945 ratio of 85; 9.7; 5.3 for the same groups. It would appear that foundry production in Germany during the last year showed an overall gain of the order of 25 per cent. The next section of the yearbook is a foundry association directory for Germany and the whole world—the entries covering the United Kingdom being particularly accurate. Finally there is a buyer's guide for the foundry industry. It is a very commendable publication.

Notes from the Branches

(*Continued from p.* 339)

station he hoped to put more questions to Mr. Talbot *en route!* Describing the Paper as being of real practical value to all foundrymen, Mr. Jackson said that all members were grateful to Mr. Talbot for this excellent and informative lecture, and thanked the speaker for the concise way in which so much information had been imparted. Seconding the vote of thanks, Mr. F. K. Vickery said that the foundry industry owed a great debt to men like Mr. Talbot, who, in so short a time developed revolutionary methods of foundry technique, and then were willing to reveal them to the industry so readily.

Book Reviews

Pocket Book for Mechanical Engineers (New Edition) by B. B. Low; published by Longmans Green & Company, Limited, 6 and 7 Clifford Street, London, W.1; price 21s. net.

The reviewer has always considered this pocket-book—now getting rather bulky to carry about—as a thoroughly reliable and comprehensive work of reference. The section on cast iron has been rewritten and now includes acicular and spheroidal-graphite irons. Curiously, for a reference-book of this character, no list of patternmaker's contractions has been included. This should be remedied in the future. For the rest, there are all the standard tables, conversion factors and just those things an engineer is constantly requiring.

Abbott's National Electrical Code Handbook, 8th edition; published by McGraw Hill Publishing Company, Limited, 95, Farringdon Street, London, E.C.4; price 56s. 6d.

This is an American book and its popularity is obvious by the fact that it has reached its eighth edition. There are no fewer than 94,702 numbered paragraphs, most of which resemble bits and pieces of standard specifications. To take one at random—No. 94,107, dealing with mercury-vapour lamps: "Resistors or regulators for mercury-vapour lamps shall be enclosed in non-combustible cases and treated as sources of heat." Several paragraphs include tables which have been adopted as standards in the USA. There are ten chapters which cover, in addition to such matters as wiring-design protection, methods and materials and equipment for general use, and much matter covering special equipment such as X-ray apparatus. The fire hazard is stressed throughout, and the book, which is based on the 1953 edition of the (American) National Electrical Code, has been brought up to date by a revision carried out by the Fire Protection Association.

The Constitutional Diagrams of Alloys—a bibliography originally compiled by Dr. J. L. Haughton—this second edition compiled by A. Prince, B.Met., and published by the Institute of Metals, 4, Grosvenor Gardens, London, S.W.1; price 35s.

The first edition of this work, which appeared in 1942, together with the supplement published in 1944, have been the much-thumbed desk-reference book of a large body of metallurgists and others. With the rapid growth of metallurgical science there has been for some time a serious gap in the literature of tabulated-bibliographical information in respect of work published since January, 1944, on the constitutional diagrams of alloys.

The appearance of this second edition will help to make good this deficiency in that the bibliography has been brought up to the end of 1954, in as comprehensive a manner as possible; in the case of many journals, work published up to the middle of 1955 has been included. The references include a comprehensive list of publications of Russian origin for the period 1944/54 inclusive. The new edition contains about twice as many references as the first edition. The compiler and the Institute of Metals are to be congratulated on the excellence of this volume, which is most welcome, and can be commended wholeheartedly to all concerned with the constitution and properties of alloys.

J. E. G.

Iron & Steel Prices Raised

As briefly announced in last week's issue increases in the maximum prices of most iron and steel products took effect on May 7; they raise the average level in the United Kingdom by 5 per cent.

A statement by the Iron and Steel Board says that the increases have in the main been necessitated by the higher cost of imported materials and of home arising scrap. The landed cost of imported materials used in the manufacture of finished products—iron ore, scrap, pig-iron, and semi-finished steel—has risen steadily over the past 15 months. As compared with the first half of 1955, the period preceding the last major change in steel prices in July, 1955, the costs of imported materials have risen approximately as follow:—Iron ore, 11s. a ton; scrap, £7 10s.; pig-iron, £5; semi-finished steel, £6.

These higher landed costs are due in part to higher f.o.b. costs and in part to higher freights. The increase in the cost of home arising scrap results from the Order made by the Board of Trade, which raised maximum prices as from May 4.

Other increased costs have to be borne by the industry, particularly as a result of the higher wages rates recently negotiated and the higher railway freight charges.

The new prices for iron and steel products do not reflect these increases, which will in consequence be carried by the industry. The extent to which the industry will be able to continue to do so will be kept under review, the board states.

Adjustments up and down in the prices of individual products have been made to correct anomalies in the price structure. Extras have been increased in a number of cases and reduced in others. Fully revised price schedules have been introduced for cold-rolled strip and stainless steel. As a result of more modern methods of production, it has been possible to avoid price increases in the wider widths and medium gauges of cold-rolled strip and to make reductions in the prices of the thinner gauges of stainless-steel sheet.

The Iron and Steel Board states that despite the increases the prices of iron and steel products in the United Kingdom market still remain below those in most other steel-producing countries, the differential being of the order of 10 per cent.

First RoSPA Award

The handsome trophy—a silver Georgian inkstand—which Sir George Earle, chairman of the Associated Portland Cement Manufacturers, Limited, presented to the Royal Society for the Prevention of Accidents, for annual award for an outstanding achievement in the cause of industrial accident prevention, has been awarded to H.M. Inspectors of Factories. This is the first time the trophy has been awarded, and before coming to its decision the Society gave very careful consideration to a large number of applications received from industrial and other organizations. (The award is not open to individuals.)

The trophy was presented at the Society's National Industrial Safety Conference, which took place at Scarborough on May 11 to 13. The presentation was made by the president of the Society, Sir Howard Roberts, C.B.E., D.L., J.P., to Sir George Barnett, H.M. Chief Inspector of Factories, who received it on behalf of his staff.

Expansion of Vickers Group

In his general review of the operations of Vickers, Limited, in 1955, Lt.-Gen. Sir Ronald M. Weeks describes the year as "extremely satisfactory." In many works full order-books have committed production capacity for most of 1956, and with some products throughout 1957.

All companies within the group have been exploring new production techniques and adding new products to their manufacturing range, the chairman declares. The English Steel Corporation, Limited, has been reorganized. This section, with Taylor Bros. & Company, Limited, and the Darlington Forge, Limited, has full order-books and achieved maximum production last year.

Despite severe competition important orders for rail stock were won during the year, but steel shortage continues to hamper production. The making of rail coaches and goods wagons for Commonwealth countries has increased, and the demand at home for equipment calls for full production this year and in some cases well into 1957. Capacity of the marine engineering department has been fully utilized, states Sir Ronald, and the mathematical and optical instrument turnover has been the highest since the war.

A milestone was reached by Vickers shipbuilding interests during the year under review. This was achieved when the launch of the millionth gross ton of shipping since the war coincided with the launch of what was then the world's largest tanker.

Group trading profit amounted to £11,980,000, compared with £7,670,000 in the previous year.

Railway Rolling-stock Contracts

Further orders for rolling stock have been placed by the British Transport Commission under the railways modernization plan. The new contracts cover a total of 1,400 wagons and 62 passenger coaches.

Contracts have been placed with the following manufacturers:—

Metropolitan-Cammell Carriage & Wagon Company, Limited, 50 30-ton bogie bolster wagons; Tees Side Bridge & Engineering Works, Limited, 100 30-ton bogie bolster wagons; Hurst, Nelson & Company, Limited, Motherwell, 150 42-ton bogie plate wagons; R. Y. Pickering & Company, Limited, Wishaw (Lanarkshire), 150 42-ton bogie plate wagons; Tees Side Bridge & Engineering Works, Limited, 500 16-ton mineral wagons; Charles Roberts & Company, Limited, Horbury Junction, Wakefield, 62 second-class brake and luggage coaches.

Fall in Labour Force

There was a fall of 182,000 to 22,940,000 in the total number of people in civil employment in Great Britain between the end of November, 1954, and the end of March this year. In the same period a year earlier the number rose by 70,000.

During March, according to figures published by the Ministry of Labour, there was a decline of 35,000 in employment in manufacturing industries. On April 16 the number of workers unemployed was 252,000—14,000 fewer than on March 12. This represented 1.2 per cent. of the total number of employees, the proportion being the same as in the previous month and as in April last year.

Pig-iron and Steel Production

Statistical Summary of February Returns

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation. Table I summarizes activities during the past six months. Table II gives production of steel ingots and castings in February, and Table III, weekly average production of finished steel. Table IV gives the production of pig-iron and ferro-alloys in February, 1956, and furnaces in blast. (All figures weekly averages in thousands of tons.)

TABLE I.—*Iron and Steel Price Index and General Summary of Pig-iron and Steel Production.*

Period.	B.o.T. Price Index, 1938 = 100. I. & S.	Coal.	Basic materials excl. fuel[1]	Iron-ore output.	Imptd. ore used.	Coke to blast. furnaces.	Pig-iron, ferro-alloys prod.	Scrap used in steel prod.	Steel (incl. alloy). Imports.[2]	Prod. ingots, castings.	Delivrs. finished steel.	Stocks.[3]
1953	260	350	506	304	207	237	215	188	17	339	262	962
1954	263	364	498	299	234	238	229	198	7	356	277	831
1955	276	399	529	311	244	246	240	213	29	381	305	1,183
1955—Sept.	284	424	541	333	247	251	246	224	37	398	329	1,224
Oct. ..	284	425	532	334	249	257	249	225	34	399	332	1,163
Nov.[4]	285	431	532	331	259	261	253	228	36	409	332	1,154
Dec. ..	285	435	539	313	268	261	250	208	35	382	320	1,183
1956—Jan. ..	285	435	537	328	278	270	261	222	38	405	337	1,208
Feb.[4]	285	435	537	315	284	269	263	226	37	418	—	1,218

TABLE II.—*Weekly Average Production of Steel Ingots and Castings in February*, 1956

District.	Open-hearth. Acid.	Open-hearth. Basic.	Bessemer.	Electric.	All other.	Total. Ingots.	Total. Castings.	Total ingots and castings.
Derby, Leics., Notts., Northants and Essex ..	—	3.9	14.1 (basic)	2.2	0.1	19.2	1.1	20.3
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire	1.4	35.2	—	2.6	0.4	38.2	1.4	39.6
Yorkshire (excl. N.E. Coast and Sheffield) ..								
Lincolnshire	—	41.0	—	—	0.1	40.9	0.2	41.1
North-East Coast	0.7	81.7	—	1.4	0.5	82.2	2.1	84.3
Scotland	3.4	44.9	—	2.6	0.5	49.1	2.3	51.4
Staffs., Shrops., Worcs. and Warwick	—	19.4	—	1.3	0.8	19.5	2.0	21.5
S. Wales and Monmouthshire	6.6	81.0	6.9 (basic)	1.2	0.2	95.2	0.7	95.9
Sheffield (incl. small quantity in Manchester) ..	9.7	33.9	—	12.0	0.4	54.0	2.0	56.0
North-West Coast	—	1.8	5.2 (acid)	0.6	0.1	7.6	0.1	7.7
Total	21.8	342.8	26.2	23.9	3.1	405.9	11.9	417.8[4]
January, 1956	19.2	334.9	25.2	23.0	2.9	393.8	11.4	405.2
February, 1955	20.7	323.2	25.5	21.5	3.3	383.1	11.1	394.2

TABLE III.—*Production of New Non-alloy and Alloy Finished Steel.*

Product.	1954.	1955.	1955. Jan.	1955. Dec.	1956. Jan.
Non-alloy steel:					
Ingots, blooms, billets and slabs[5]	5.1	4.9	5.2	4.6	4.8
Heavy rails ..	9.6	9.4	9.8	9.2	9.2
Sleepers, fishplates and soleplates ..	1.9	2.0	1.4	3.2	1.9
Plates ¼ in. thick and over ..	47.0	46.1	43.7	51.0	50.4
Other heavy prod.	45.8	47.8	47.8	47.3	50.4
Ferro-concrete bars etc.	5.9	7.0	7.1	7.2	7.7
Wire rods, incl. coiled rods, etc.	19.7	22.2	23.1	23.0	25.1
Light rolled prod.	41.2	46.4	45.1	48.8	52.4
Bright steel bars ..	6.3	7.8	7.4	8.1	8.9
Hot-rolled strip ..	21.7	24.1	24.3	23.3	26.5
Cold-rolled strip ..	7.0	8.1	8.1	8.1	9.1
Sheets, incl. coated	38.8	42.7	43.8	40.2	45.5
Tinplate, terneplate and blackplate ..	16.8	17.0	18.0	16.7	17.0
Tubes and pipes ..	20.0	22.9	21.3	23.7	24.3
Tube, pipe fitgs ..	0.4	0.4	0.4	0.5	0.5
Tyres, wheels and axles	4.7	4.8	4.6	4.7	4.4
Forgings (excl. drop forgings) ..	2.6	2.5	2.4	2.7	2.9
Steel castings ..	4.0	4.2	4.1	4.2	4.3
Tool and magnet steel	0.2	0.3	0.3	0.3	0.3
Total	298.7	320.6	317.9	326.8	345.6
Alloy steel	13.2	15.3	14.9	15.9	17.3
Total deliveries from U.K. prod.[6] ..	311.9	335.9	332.8	342.7	362.9
Add: Imported finished steel ..	5.0	18.8	10.7	26.2	30.2
	316.9	354.7	343.5	368.9	393.1
Deduct: Intra-industry conversion[7] ..	41.5	50.4	46.8	50.2	57.1
Total net deliveries of new material ..	275.4	304.3	296.7	318.7	336.0

TABLE IV.—*Production of Pig-iron and Ferro-alloys during February*, 1956.

District.	Furnaces in blast.	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts., Northants and Essex	26	1.5	20.6	25.7	1.2	—	49.0
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire ..	7	—	20.2	—	—	1.6	21.8
Yorkshire (excl. N.E. Coast and Sheffield) ..							
Lincolnshire ..	10	—	38.0	—	—	—	38.0
North-East Coast	21	4.7	49.8	0.1	—	1.4	56.0
Scotland	9	0.3	16.0	1.9	—	—	18.2
Staffs., Shrops., Worcs., and Warwick ..	7	—	10.4	1.5	—	—	11.9
S. Wales and Monmouthshire	11	4.7	39.7	—	—	—	44.4
Sheffield	2	—	3.2	—	—	—	3.2
North-West Coast	9	19.5	—	0.2	—	1.1	20.8
Total ..	102	30.7	197.9	29.4	1.2	4.1	263.3[4]
January, 1956 ..	102	29.5	195.1	31.5	1.0	3.6	260.7
February, 1955 ..	99	27.1	179.2	30.4	1.1	3.9	241.7

[1] Used in non-food manufacturing industry.

[2] Weekly average of calendar month.

[3] Stocks, mainly ingots and semi-finished, at the end of the years and months shown.

[4] Five weeks, all tables.

[5] Other than for conversion into any other form of finished steel listed.

[6] Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.

[7] Material for conversion into other products also listed in this table.

New Patents

(Copies of complete specifications are obtainable from the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 3s.)

744,921. Inland Steel Company, 38 South Dearborn Street, Chicago, Illinois, USA.

An improvement in the process for making low-phosphorus low-nitrogen steel from pig-irons of widely varying phosphorus content (according to patent specification No. **685,326**). The slag, iron-oxide and metal phases are turbulently intermixed with consequent early elimination of phosphorus to not more than 0.04 per cent. and simultaneous elimination of at least 0.4 per cent. carbon but leaving at least 1 per cent. carbon in the metal. The turbulent mixing is substantially enhanced by the gases evolved during elimination of carbon and an operating temperature of not less than 1,370 deg. C. being developed. The basic slag should have a weight per cent. ratio of lime to silica of at least 2.0 and the elimination of phosphorus to substantially the extent required in the final product is accomplished while the carbon content of the metal is not less than 2 per cent. The oxidizing gas consists of free oxygen.

744,935. Gesellschaft Fur Hutten-und Stahlverfahren mit Beschrankter Haftung, Nisterhammer, Post Hachenburg, Germany.

A process and apparatus for the continuous production of purified iron of different qualities from pig-iron of any composition. The invention aims at avoiding insufficient utilization of heat energies in the refining process and the detrimental increasing of the nitrogen content of the purified iron. Unlike usual practice the container to which the molten pig-iron is supplied remains stationary during refining process.

745,013. Bristol Aeroplane Company, Limited, Stock Exchange Buildings, St. Nicholas Street, Bristol.

A process of surface hardening steel machine parts by a carburizing process and the heat-treatment of the parts afterwards. The carburizing is carried out by heating the steel with solid carbonaceous material to a temperature between 900 deg. C. and 1,200 deg. C. for a period up to 12 hours according to the temperature used and depth of hardening required. After carburizing the part is heated to a temperature of 1,050 deg. C. for ½ hr. and then quenched in oil and reheated to a temperature of 500 deg. C. before cooling in air.

745,037. Metro-Cutanit Limited, Grappenhall, Warrington, Lancs.

A crucible, casting mould or lining of a material comprising at least one nitride or mixed crystals of a carbide and nitride of the transitional metallic elements of groups IV, V, and VI of the periodic table. The invention aims at avoiding the combination of carbon with molten metal when crucibles of graphite are used in the melting under vacuum of or in an atmosphere of a noble gas, titanium, zirconium or the like high-melting-point metals.

745,205. Vereinigte Osterreichische Eisen und Stahlwerke A.G., Muldenstrasse 5, Linz-Donan, and Oesterrichische-Alpine Montangesellschaft, Friedrichstrasse 4, Vienna, 1, Austria.

A process for the manufacture of high-grade steel from pig-iron or iron containing carbon and phosphorus by refining with oxygen or with a gas enriched with oxygen.

745,234. Eutectic Welding Alloys Limited, Abbey House, Victoria Street, London, S.W.1.

An alloy consisting of (by weight) silver from 0.2 to 12, copper from 43 to 50, and nickel from 9 to 12 per cent., together with a total of between 0.1 and 1 per cent. by weight of silicon and/or manganese and/or phosphorus. The remainder is zinc. This alloy is suitable for welding, brazing, soldering or oxy-acetylene welding.

745,288. A. B. Smith and C. R. Smith, The Foundry, Stewart Street, Wolverhampton.

An improved process of making cores and moulds by shell moulding. Curing and hardening of the shell after application to a patternplate or corebox is carried out by a closed heating-circuit. A heating medium at a temperature between 150 and 260 deg. C. is continuously circulated by a fan or blower between the heating means and the back of the shell while the shell is on the patternplate, or surface of the corebox, for the duration of the curing and hardening treatment.

745,363. R. C. Butler, 3, Park Street, Hatfield, Herts.

A method of making a casting which comprises impasting the surface of a mould with one or more layers of one or more alloys. It is stated that the application of the alloys is carried out with a platinum or chromium-alloy steel spatula, and that the metal alloys employed comprise about 40 per cent. tin, 45 per cent. lead, and about 15 per cent. copper.

745,402. Wilhelm Schmidt, Pohlystrasse 11b, Frankenthal, Germany, and Walter Philipp, Karl Marx Strasse 15, Frankenthal, Germany.

A process for the production of foundry cores and moulds. A moulding sand is mixed with a binding agent. This binding agent comprises a silicate solution, and a water-soluble emulsifiable or saponifiable organic substance. This may consist of sugar, molasses, dextrin, starch, glycerine, glycol and fatty acid. The mixture is then caused to harden by the introduction of CO_2 Process.

745,427. J. B. Brennan, 13018 Lake Shore Boulevard, Cleveland, Ohio, USA.

Continuous casting process. The molten metal is fed into a die passage and whilst the metal flows through the die, the metal which contacts and moves with respect to the die wall is inductively heated, so that part of the metal is maintained plastic or molten throughout its travel through the die.

745,440. Friedrich Nielsen, 12 Fichtenweg, Muhluchen, Wurttemberg, Germany.

A modification of the method of casting, preferably of light metals, according to patent No. 690,790 which is characterized by the application of the method to centrifugal casting.

745,443. Walker and Woodward Limited, Wellington Works, Legge Lane, Birmingham, 1, Warwicks.

A metal alloy consisting of copper 85 to 95; zinc 14.8 to 4; and tin 0.2 to 2 per cent. The copper and zinc components have a purity of 99 per cent. or better, such as can be obtained by electrolytic extraction or refinement. Before casting, a pellet of a proprietary material known as Pelloids marketed by Foundry Services Limited, may be added to the molten metal for the purpose of de-oxidizing and de-gasifying the metal.

745,669. Die Casting Machine Tools Limited, and A. R. Mills, 152 Green Lanes, Palmers Green, London, N.13, and E. A. R. Mace, 21 Monkfirth Way, Southgate, London, N.14.

Die-casting and similar machines having a toggle-operated movable die-plate.

Imports and Exports of Iron and Steel in March

The following tables, based on Board of Trade returns, give figures of imports and exports of iron and steel in March. Totals for the first three months of this year and last are also included.

Total Exports of Iron and Steel

Destination.	Month ended March 31.	Three months ended March 31.	
	1956.	1955.	1956.
	Tons.	Tons.	Tons.
Channel Islands	320	1,969	1,494
Cyprus	372	1,358	803
Sierra Leone	834	2,013	1,723
Gold Coast	3,261	7,529	7,142
Nigeria	4,944	10,617	16,116
Union of South Africa	6,515	23,882	24,314
Rhodesia and Nyasaland	8,492	19,151	16,229
Tanganyika	610	3,566	3,207
Kenya	882	16,358	8,695
Uganda	78	1,379	1,602
Anglo-Egyptian Sudan	1,429	5,537	5,338
Mauritius	367	672	594
Aden	412	3,483	1,490
Bahrain, Qatar, and Trucial States	432	3,266	2,280
Kuwait	211	1,185	477
India	24,371	39,466	79,218
Pakistan	2,500	17,578	12,601
Singapore	3,170	10,682	8,339
Malaya	3,541	4,708	8,378
Ceylon	4,456	5,646	8,742
British North Borneo	302	849	1,563
Hongkong	5,677	12,722	14,440
Australia	20,203	130,492	61,033
New Zealand	14,871	73,256	49,247
Canada	26,780	21,038	60,706
Jamaica	1,953	2,881	6,368
Trinidad	3,481	16,326	10,186
British Guiana	741	1,677	1,517
Other Commonwealth countries	2,086	6,650	5,718
Eire	5,901	14,759	16,954
Finland	3,221	20,649	11,072
Sweden	9,176	36,296	29,825
Norway	6,518	34,378	20,807
Denmark	4,177	22,801	13,831
Western Germany	584	2,242	3,104
Netherlands	8,639	29,067	23,027
Belgium	4,428	5,291	9,425
France	825	1,912	2,228
Switzerland	1,427	4,130	3,882
Portugal	837	3,198	2,056
Spain	3,948	3,498	6,738
Italy	1,739	6,744	5,349
Austria	552	595	1,357
Yugoslavia	31	4,960	1,198
Greece	185	2,433	1,384
Turkey	32	2,422	777
Netherlands Antilles	1,808	3,268	3,539
Portuguese E. Africa	92	416	684
Lebanon	859	255	2,485
Egypt	5,089	10,773	12,025
Israel	2,184	2,964	3,464
Saudi Arabia	69	3,061	1,999
Iraq	3,963	6,685	10,172
Iran	3,910	13,524	16,929
Burma	1,253	4,031	1,960
Thailand	285	1,514	2,348
Indonesia	1,731	1,083	3,462
Philippine Republic	1,274	1,063	1,830
USA	3,084	11,210	9,966
Cuba	1,100	964	3,090
Colombia	199	2,554	583
Venezuela	7,086	21,252	16,989
Ecuador	214	759	734
Peru	1,205	2,427	5,008
Chile	93	374	141
Uruguay	883	3,120	1,591
Argentina	6,481	16,914	14,218
Other foreign countries	2,999	9,170	6,938
TOTAL	241,372	708,692	692,729

Total Imports of Iron and Steel

From	Month ended March 31.	Three months ended March 31.	
	1956.	1955.	1956.
	Tons.	Tons.	Tons.
Rhodesia and Nyasaland	205	835	649
Australia	—	7	14
Canada	3,802	13,086	12,985
Other Commonwealth countries and Eire	363	641	1,670
Soviet Union	18,342	43,671	78,743
Sweden	2,879	7,837	10,283
Norway	9,836	18,933	30,759
Western Germany	26,542	5,466	61,495
Netherlands	12,951	31,898	36,857
Belgium	39,516	21,026	117,403
Luxembourg	5,448	6,485	21,188
France	27,860	30,651	92,668
Italy	1,026	72	2,891
Austria	21,618	35,992	54,233
Japan	2,189	1,257	5,767
USA	57,947	138,673	159,899
Other foreign countries	2,550	110	12,123
TOTAL	233,074	356,640	699,627
Iron and steel scrap and waste, fit only for the recovery of metal	58,787	277,694	255,235

Exports of Iron and Steel, by Product

Product.	Month ended March 31.	Three months ended March 31.	
	1956.	1955.	1956.
	Tons.	Tons.	Tons.
Pig-iron	11,396	15,698	26,891
Ferro-colombium (niobium)	18	37	46
Ferro-tungsten	143	140	276
Other ferro-alloys	246	659	790
Ingots, blooms, billets, slabs, sheet, and tinplate bars	262	2,435	753
Iron bars, rods, angles, shapes, and sections	111	1,229	468
Steel bars, rods, angles, sections, and shapes	36,768	123,736	104,612
Iron plates and sheets	8	36	70
Universal plates	263	3,101	1,483
Steel plates, ⅛ in. and under ⅜ in.	875	5,193	2,727
Do., ⅜ in. and over	18,406	75,629	58,056
Black sheets and black plate	16,557	64,601	67,187
Hoop and strip	6,941	33,813	24,100
Tinplate	26,679	87,789	75,210
Decorated tinplate	584	763	1,910
Galvanized sheets	11,138	43,365	33,538
Other (incl. tinned sheets, terne-plate, and ternesheets)	1,057	4,040	3,570
Railway and tramway construction material	27,129	72,069	79,874
Wire rods	3,455	9,683	8,935
Wire	8,094	30,121	24,404
Tubes, pipes, and fittings	70,427	190,252	185,894
Iron castings	171	2,938	432
Steel castings	168	515	430
Forgings	476	850	1,073
TOTAL	241,372	768,692	692,729

PRELIMINARY preparations are already in hand for the 1957 British Industries Fair, which will be held at Castle Bromwich, Birmingham, from May 6 to 17.

TRANSMISSION ACCESSORIES, LIMITED, a company associated with Foundry Equipment, Limited, Linslade Works, Leighton Buzzard, are manufacturing precision pneumatic valves under licence from Numatics Inc., of Milford, Michigan, USA.

News in Brief

FORDATH ENGINEERING COMPANY, LIMITED, Hamblet Works, West Bromwich, announce that their telephone numbers have been consolidated into West Bromwich —1665.

TIVIDALE ENAMEL COMPANY (Proprietors, Revo Electric Company, Limited), Groveland Road, Tipton, Staffs, announce that in future their title will be Tipton Enamel Company.

REFINED IRON COMPANY (DARWEN), LIMITED, announce that their head office address is now the same as the works, namely, Spring Vale Works, Grimshaw Street, Darwen (telephone: Darwen 1155).

THE FACTORIES of George Kent, Limited, at Luton, London, and Resolven, South Wales, will be closed for the annual works holiday from Friday evening, July 20, to Tuesday morning, August 7. Offices at all factories will remain open and staffed during the holidays.

THE City and Guilds Broadsheet (No. 2) announces that Insignia Awards in technology have been given to Mr. F. R. Smith, of the Liverpool works of the English Electric Company, Limited (engineering), and Mr. J. Wilkinson, M.C., Yorkshire Copper Works (non-ferrous metallurgy).

BRITISH FOUNDRY UNITS, LIMITED, Retort Works, Chesterfield, announce that the Vortec range of core-sand mixers has now been increased by a third and larger model, which will handle 400 lb. of sand at one mix and complete its task in three to five minutes according to the bond used.

SAMUEL OSBORN & COMPANY, LIMITED, Clyde Steel Works, Sheffield, have bought 73 acres of land at Halfway, Eckington, Derbyshire, for future development. The firm's statement says "The area is sufficient for all foreseeable requirements of the group—comprising 20 companies—for many years."

THE SECOND DISCUSSION ON THE CO_2 PROCESS organized by the British Cast Iron Research Association is to be held at the Royal Empire Society rooms, 18, Northumberland Avenue, London, W.C.2, on May 29 and 30. Details are available on writing to the BCIRA at Alvechurch, Birmingham.

AN ANNUAL DONATION of £1,000 is to be made by British Timken, Limited, to assist boys wishing to attend Northampton Technical High School. These awards will be known as Timken Exhibitions and will be available to Northamptonshire schoolboys over 16 who wish to follow a science course at advanced level.

FOR THE FIRST MONTH in nine years there were no reportable accidents in the heavy constructional department of the engineering division of Newton, Chambers & Company, Limited, during March. The department, which comprises the machine and fitting shop, the patternshop, construction shop, Ensecote, and erection department, has just over 800 operatives.

THE SPORTS CLUB of Parker Foundry (1929), Limited, Derby, held their annual dinner in the works canteen on May 4. Mrs. R. A. Duff, wife of the new general manager, presented trophies to winners of events in both indoor and outdoor sports. Mr. J. Martin, personnel manager, welcomed Mr. R. A. Duff, the new general manager, and Mr. R. Marriott, the new works manager.

A £7,000,000 CONTRACT for the main civil engineering work for the £48,000,000 extensions to the Abbey and Margam works of the Steel Company of Wales, Limited, at Port Talbot, has been obtained by Sir Robert McAlpine & Sons. Work is to start immediately. The contract covers heavy engineering work in laying foundations for the new blast furnace and ancillary plant.

AMONG THE 108 RESOLUTIONS tabled for the annual conference of the Amalgamated Union of Foundry Workers at Llandudno at the end of the month are several concerned with automation. It is asked that a watch be kept for possible redundancy so that shorter hours may be pressed. Another resolution will demand that any company dividend above 5 per cent. must be used to reduce prices or be taken over by the Government.

DAVY & UNITED ENGINEERING COMPANY, LIMITED, Darnall, Sheffield, have received an order from Spain for two presses worth £76,000. They are for the Sociadad Española de Construccion Naval, Reinosa, and are to be delivered in the summer of 1957. The 600-ton upsetting press, and a 1,200-ton trimming and bending press are for marine-engineering construction work, and driven by a common hydraulic service. Work has just been completed on the £1,000,000 order for rolling-mill plant for the Spanish national steelworks at Aviles.

Mr. E. N. HILEY, secretary of the National Brass Foundry Association, spoke to the Rotherham Junior Chamber of Commerce on Monday, May 7, on the Restrictive Practices Bill. He said, "When somebody cuts his price to be a little more competitive, the other man cuts his also, and so we have everybody getting little or no profit." He said this rake's progress eventually led to the customer getting a cheap and nasty article instead of the traditionally good British one. Price cutting could also lead to deterioration of the workers' position. He agreed that there were some monopolistic and racketeering practices, but these were in the minority.

THE FOUNDRY DIVISION of Dohm, Limited, is claimed to be the most rapidly expanding side of the Group's activities. At the British Industries Fair, the firm's resin-coated sand for shell moulding and core bonding was featured. Also shown was a refractory wash, which is being widely used to protect firebricks. Other items on display included exfoliated vermiculite, thermal-insulation material, investment-base, pulverized raw materials including silica, manganese, graphite, etc., and metallic pastes and powders. It is interesting to learn that the CO_2/sodium silicate process is being adopted by the Dohm concern to bond vermiculite into block form for building insulation and construction purposes.

THE NATIONAL INDUSTRIAL SAFETY CONFERENCE and Trade Exhibition of industrial safety appliances, organized annually by the Royal Society for the Prevention of Accidents, was held at Scarborough, from May 11 to 13, under the chairmanship of Mr. R. E. Tugman, division safety officer, alkali division, Imperial Chemical Industries, Limited. This year the function was attended by nearly 600 delegates from all branches of industry, while about 50 manufacturers and organizations were represented in the trade exhibition. Following a civic reception the presidential address was given by the president of the Society, Sir Howard Roberts, C.B.E., D.L., J.P. The opening address to the conference was given by the Rt. Hon. Iain Macleod, M.P., Minister of Labour and National Service. Among the papers that were read was one on "Dust Suppression in Industry" by Mr. W. B. Lawrie, M.B.E., M.SC.

Personal

MR. L. C. NICHOLLS has resigned from the board of the Chinese Engineering & Mining Company.

Mr. H. J. BULLOCK has been appointed to the board of directors of British Moulding Machine Company, Limited.

DR. N. A. DUDLEY has been appointed head of the department of engineering production at Birmingham University for a period of three years.

K & L Steelfounders & Engineers, Limited, Letchworth, Herts, announce that Mr. HARRY H. WEBSTER, of Larbert, Stirlingshire, has joined the foundry division as sales manager.

Mr. J. E. A. HEALE, A.M.I.E.E., who joined the Metropolitan-Vickers Company, Limited, as a college apprentice in 1929, has been appointed manager of the company's Motherwell works.

Mr. D. K. FRASER has been appointed managing director of Petters, Limited. He succeeded Captain R. C. PETTER, the former managing director, in April last year, as director and general manager.

MR. PHILIP WRIGHT has been appointed general manager of the company shortly to be formed to take over the foundry and engineering activities of the Brightside Foundry & Engineering Company, Limited.

MR. STANLEY RUSSELL HORN has been appointed area sales manager for Yorkshire and the North Eastern Counties for the British Materials Handling Division of the Yale & Towne Manufacturing Company.

British Oxygen Company, Limited, announce the appointment of Mr. JOHN G. THOM as sales manager for Northern Ireland. Mr. Thom has been with the company for 35 years, and has served in Glasgow, Aberdeen, Leith and Dundee.

Mr. JAMES PATERSON, who has been appointed Provost of Falkirk, after an equal vote, is an ironmoulder, employed by Grahamston Iron Company, Limited. He entered the town council in 1945 and was beaten for the Provostship three years ago.

MR. J. P. CUMMINGS, general superintendent of the foundry division of the Doncaster works of International Harvester Company, Limited, who came to this country from the USA seven years ago, is leaving Doncaster to return to the company's headquarters in Chicago.

MR. CECIL W. STIMPSON, manager of the stores and packing department of J. W. & C. J. Phillips, Limited, New Cross, London, S.E.14, was recently presented with a television set by the directors, in appreciation of the completion of 50 years' loyal service with the company.

DR. GALLOWAY, director of research, Production Engineering Research Association, left England on May 9 for Canada and the USA. His principal engagement is to give the Calvin W. Rice memorial lecture to the American Society of Mechanical Engineers.

William Cumming & Company, Limited, Newbridge Lane, Old Whittington, Chesterfield, announce that MR. B. VAUGHAN, of 7, Beech Road, Kensworth, Nr. Dunstable, Beds, has been appointed their representative for the South of England and South Wales, in place of MR. A. HARES, who has now retired.

Dr. ROBERT J. ANDERSON has resigned his position as head of the department of metallurgy, Southwest Research Institute, San Antonio, Texas, where he has served during the last five years, to join the Diamond Metal Company, Inc., and associated enterprises, Houston, Texas, as director of research and development. Before moving to Texas, he practised as a consulting metallurgist for many years, with headquarters at Cleveland, Ohio.

A NEW MEMBER of the board of directors of the Dowty Group, Limited, mining machinery manufacturers, of Cheltenham, is MR. ROBERT FREDERICK HUNT, who joined the concern in 1935, as one of its first two apprentices. On the conclusion of his apprenticeship in 1939, Mr. Hunt became a designer and in the following year was appointed chief instructor of the Dowty School of Hydraulics, in which capacity he was attached to the RAF Technical Training Command.

MR. T. H. WEAVER, who was made president-elect of the Birmingham, Coventry and West Midlands branch of the Institute of British Foundrymen on April 25, rose from the shop floor to become successively charge hand, foreman and foundry manager. He is with W. & T. Avery, Limited, of Soho Foundry, and is on the management committee of the Foundry Craft Training Centre at West Bromwich. During both world wars Mr. Weaver was in charge of important foundrywork for the Admiralty and for aircraft production.

SIR HAROLD WEST has retired from his position as managing director of Newton, Chambers & Company, Limited, Thorncliffe, near Sheffield, and on May 8 he received presentations to mark the occasion. The ceremony was attended by hundreds of employees representing all the work's departments. Mr. Lionel Teasdale, who joined the firm's moulding shop 60 years ago, presented Sir Harold with a bookcase made by the company's craftsmen, while Mr. T. Parkinson presented him with a gold-mounted and inscribed walking stick.

MR. N. P. NEWMAN, chairman of the Council of Ironfoundry Associations, has sailed on a visit to Canada and the USA. During a stay of six weeks, he hopes to further United Kingdom trade interests in both countries. His programme has already included a visit to Atlantic City, New Jersey, where he has been attending the American Foundrymen's Society's convention and exhibition as the official representative of the Institute of British Foundrymen. His trip covers also Toronto, Winnipeg, Calgary, Vancouver, Edmonton and Montreal. In Calgary he is addressing Canadian business men on those aspects of British industry likely to be of special interest to Canadians and he is also giving a broadcast talk on the manufacture of valves and equipment for oil refining and production.

Obituary

The death occurred on Saturday, May 5, of Mr. JOHN WILKINSON, at the age of 77. Mr. Wilkinson was senior partner of Richard Wilkinson & Company, general patternmakers, Central Pattern Works, Park Street, Keighley.

Mr. FRED TAYLOR, who has died at the age of 80, was a director of Tipper Industries, Limited, Birmingham, and until his retirement in 1950 was joint managing director of the subsidiaries. Arthur Tipper, Limited, ironfounders, etc., and John Tipper & Company, Limited, makers of builders' ironmongery, both of Willenhall. For many years he was chairman of Willenhall and District Ironfounders' and Manufacturers' Association.